OPENING OF THE NEW EAST RIVER BRIDGE.

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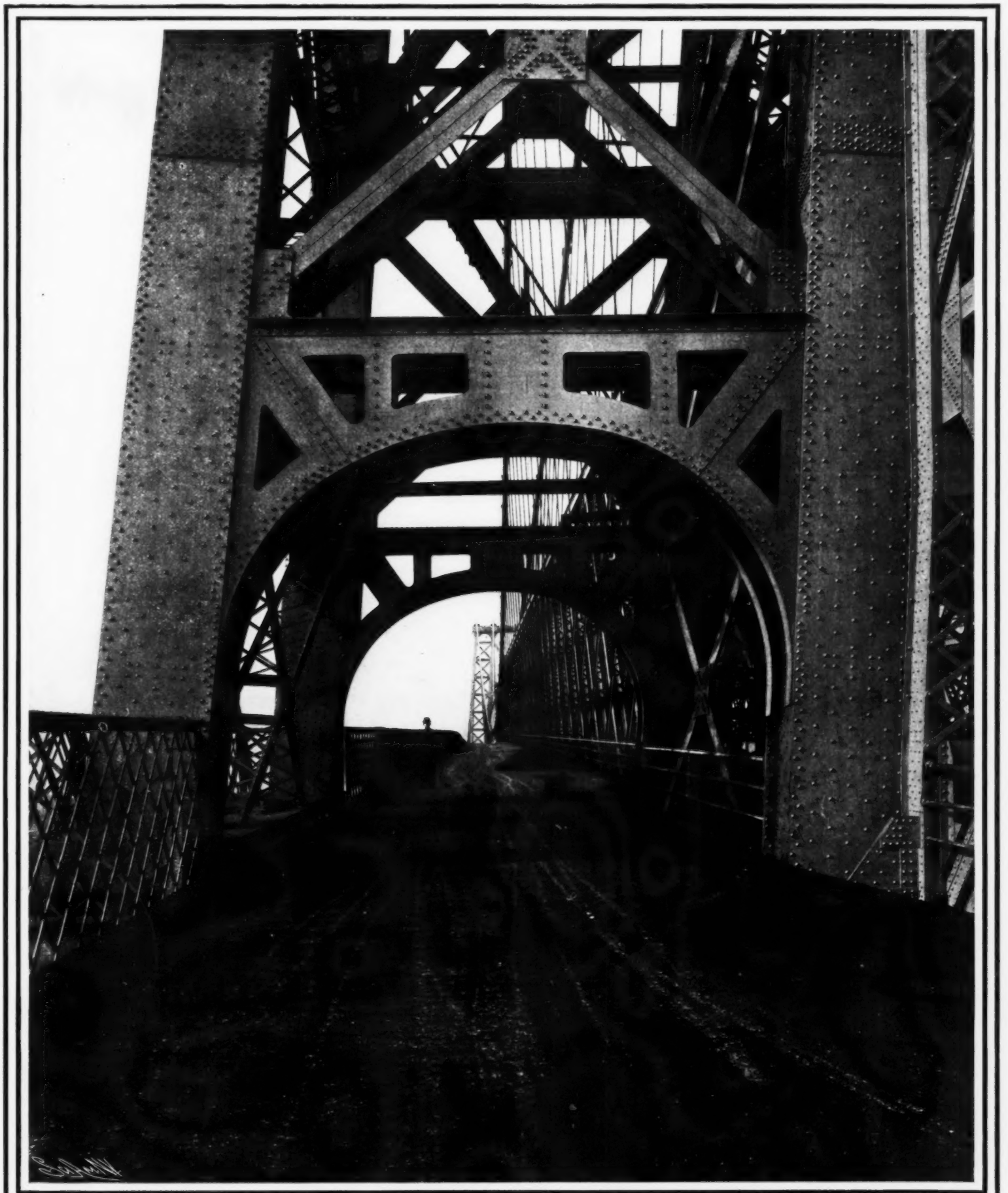


VIEW FROM THE BROOKLYN TOWER, LOOKING THROUGH ONE OF THE 18-FOOT ROADWAYS.

THE OPENING OF THE NEW EAST RIVER BRIDGE.

THE OPENING OF THE NEW EAST RIVER BRIDGE, NEW YORK.

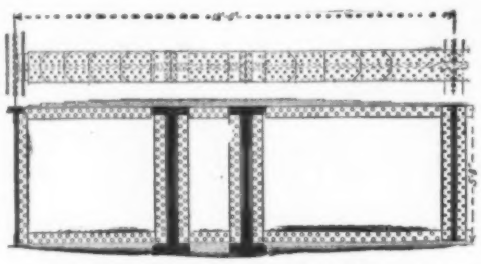
On Saturday, December 19, the great bridge which for the past seven years has been in process of building across the East River, was opened with appropriate ceremonies by the Hon. Seth Low, Mayor of New York. It was peculiarly fitting that it should have fallen to the lot of this distinguished citizen to perform this ceremony for it was chiefly due to his initiative and business capacity that the Brooklyn suspension bridge, a mile and a half further down the East River, was carried to completion and opened some twoscore years ago.

This great suspension bridge, which is considerably the largest structure of its kind in the world, was begun in 1896, and, therefore, has been some seven years under construction. It spans the river between the foot of Delancey Street, Manhattan, and the foot of South Fifth and South Sixth Streets, Brooklyn, and has a total length from the entrance at street grade in Manhattan to the entrance in Brooklyn of 7,200 feet. The main span is 1,600 feet in the clear. The bridge from approach to approach has a clear width of 118 feet, and provides accommodation for two elevated railway tracks, four street railway tracks, two 18-foot roadways, two footpaths, and two bicycle tracks. There is no bridge in the world that can compare with this in carrying capacity. It was designed by L. L. Buck, M.Am.Soc. C.E., and was carried to completion under the present Bridge Commissioner, Gustav Lindenthal.

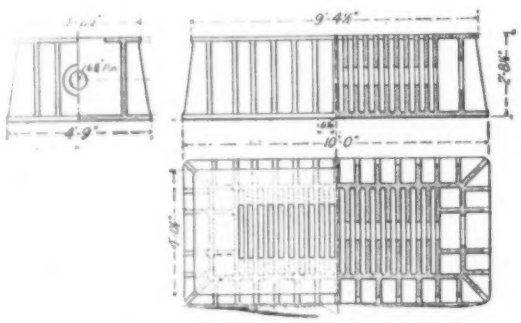
The Foundation.

It can be well understood that in building a structure of these vast dimensions, whose term of life should be reckoned by the thousand years, the most important consideration is the foundations inasmuch as upon these the stability of the whole structure depends, and when they are once put in, they are forever beyond the reach of alteration or repair. It is conceivable that faulty design or poor material in the superstructure might be remedied, even after the bridge was completed—so great is the skill and resourcefulness of the modern engineer; but blunders in the design or construction of the piers of a 1,600-foot suspension bridge would probably wreck it beyond all hope of recovery.

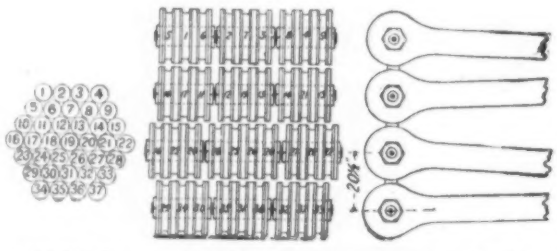
The foundations of the new bridge consist of timber caissons filled in with concrete. Owing to the varying depth of the rock below the surface of the river, no two of the caissons are of the same dimensions, although they are similar in construction. The structure which is shown in the accompanying illustrations is the north caisson of the New York tower, and the description of the plant and methods employed in sinking it to place will apply also to the work on the other three. The borings show that the bed of the river consists mainly of sand, with some clay and bowlders. Below this, at a depth which varies from 45 to 71 feet below high water, is a very irregular surface of gneiss rock, similar to that which is found on Manhattan Island. The caissons were sunk through the sand until they touched the rock, which was blasted away and "stepped" until the edge came to a fair bearing on all sides. When this had been done, the space between the rock and the roof of the caisson was carefully filled in with concrete.



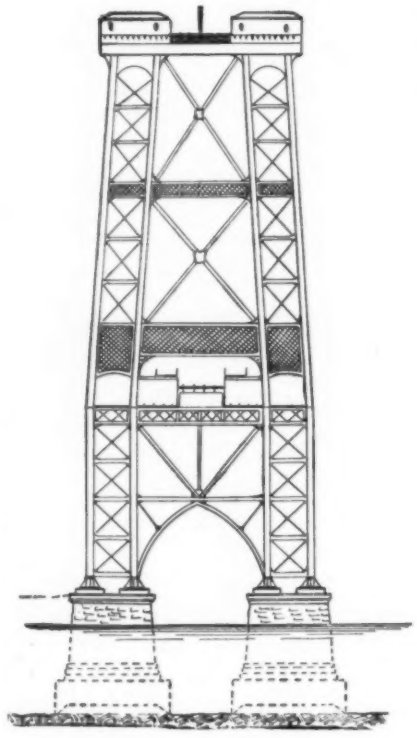
DETAIL OF ANCHORAGE GIRDERS FOR INSIDE CABLES.



ANCHORAGE PLATE—WEIGHT, 11¾ TONS.



METHOD OF ATTACHING CABLE STRANDS TO ANCHOR CHAINS.

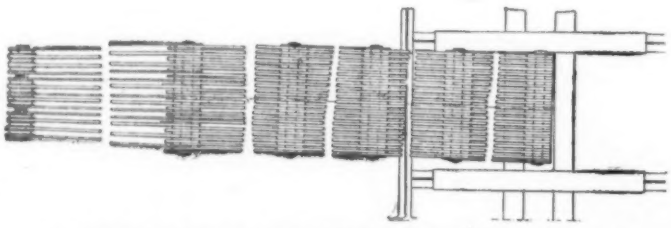


FRONT ELEVATION OF TOWER.

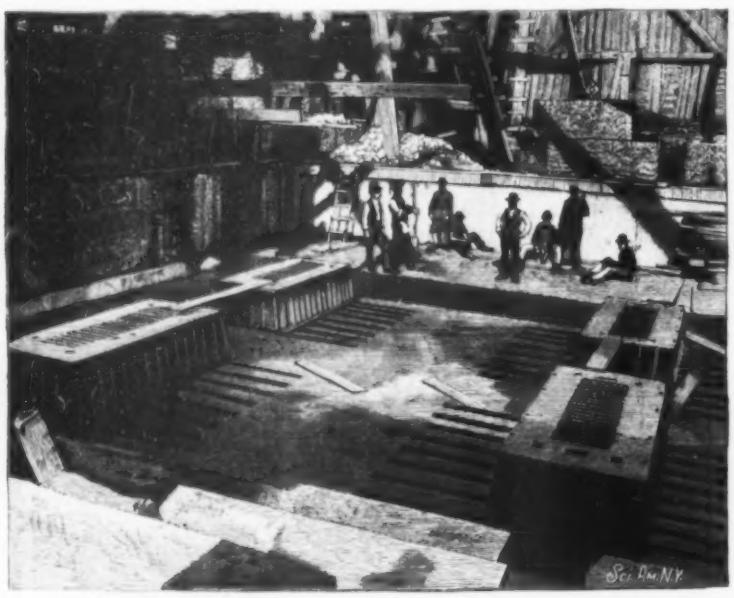
Roughly speaking, the caisson, with its attached cofferdam, may be described as a huge boxlike structure, 60 feet by 76 feet on the sides and 19 feet deep, fitted with a bottom, which is placed, not at the lower edge of the sides, but 7½ feet above it. The space below the bottom or "roof," as it is called, constitutes a working chamber in which the blasting and excavation of the river bottom is carried out. Its walls are two feet nine inches thick and consist of two courses of 12 x 12 inch timbers, the outer course being horizontal and the inner vertical, on the outside of which are two layers of 3-inch plank and one layer of the same thickness is laid on the inside.

The bottom of the walls was furnished with a cutting edge, which extends continuously around the whole caisson. It was built up of ½-inch steel plates, and it extended two feet below the bottom of the lower timbers, being stiffened at every two and a half feet of its length by knee braces. The lower twelve inches of the edge was also stiffened with reinforcing plates, which brought its total thickness up to two inches. It should be mentioned that the cutting edge was not intended for literally cutting through the river bottom, as its name would imply, but was put in to enable the workmen to use their tools close up to the outside of the caisson, and, indeed, just a few inches beyond it. The wall proper is nearly a yard thick, and if a bowlder were lodged beneath it—supposing the cutting edge were not in use—it would have been a more difficult operation to get at it than it was when the wall was only, as in this case, two inches in thickness. The shoulder, moreover, gave room to shore up if it proved necessary.

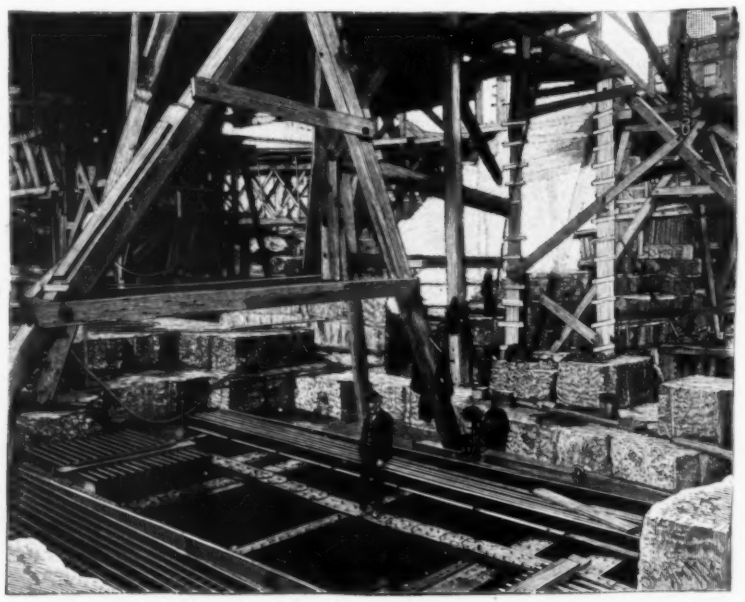
The roof of the working chamber was five feet in thickness, and consists of the following material: First, there were two courses of three inch plank, laid in opposite directions; then a layer of 12 x 12 timbers, followed by a layer of 12 x 14 timbers, laid crosswise; above this were two courses of three inch plank laid diagonally, and above these two more layers of 12 x 12 timbers. All the joints in this working chamber and in the side walls were carefully calked and white-leaded, so as to make it perfectly airtight. The roof, and indeed the whole caisson, was stiffened with a series of massive plate steel riveted trusses, eight in all, which extended entirely across it from wall to wall. They were placed immediately above and transversely to the first course of 12 x 12 inch timbers, the successive upper layers being framed in carefully between the struts and ties of the trusses. The timbers of the whole caisson, both walls and roof, were securely drift-bolted together, and every care was taken to make this structure both rigid and waterproof. The details of this construction are clearly seen in the sectional view, showing the sinking of the caisson, and in the views taken during its construction. The working chamber was also strengthened with two solid bulkheads two feet four inches thick, which extended entirely across it, dividing it into three compartments, openings being left to allow the workmen to pass through. At the level of the bottom of the walls was a massive framework or gridiron of 16 x 16 inch timbers, which was bolted together and to the side walls



PLAN SHOWING ARRANGEMENT OF LOWER ANCHOR CHAIN BARS FOR ALL CABLES.



ANCHOR PLATES FOR INSIDE CABLES, BEFORE THE GIRDERS WERE IN PLACE.



ANCHOR PLATFORM FOR SIDE CABLE, WITH FLOORING OF STEEL DECK BEAMS TO RECEIVE MASONRY.

with one and one-half inch tie rods. At each intersection vertical posts reached from this frame to the roof, and the whole system was tied together and stiffened against lateral distortion by diagonal struts and tie rods, as shown in the sectional view. The object of this mass of bracing and truss work was not merely to enable the roof to carry the superincumbent load of the masonry, but to enable the whole caisson to endure without distortion the heavy transverse strains to which it was subject when it became "hung" upon any projecting point of the uneven rock bottom.

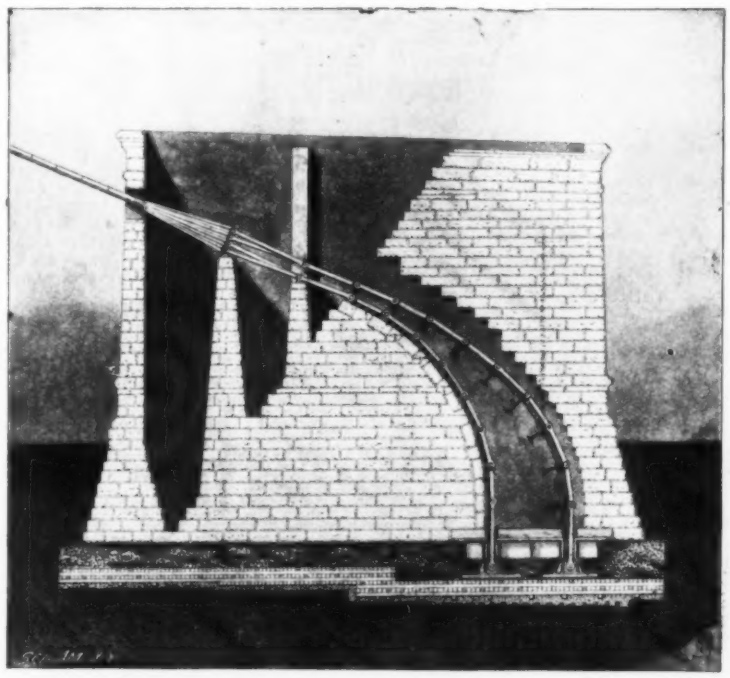
The steel trusses, which are 9 feet 3 inches deep and weigh 10 tons each, were a novel feature in this class of work. They were rendered necessary by the shallowness of the caisson, which was in turn due to the unusually short distance to solid rock.

The roof was pierced with seven shafts, each about 3 feet diameter, for the passage of men and materials, and also with a number of pipes from 1 inch to 5 inches diameter, for supplying air and water, blowing out sand, and for carrying the electric light wires. The shafts were circular in section and put on in lengths of 8 feet, as the masonry was built up.

The caisson was built up as described to its full height of 19 feet, on launching ways, and previous to the launch a cofferdam or temporary wall, 10 feet in height, was added above this structure, and bolted to it with angle plates and tie rods. The object of this was to keep the water away from the masonry while the caisson was being sunk to the bed of the river. When the caisson rested on the sand and the masonry pier was well above high water, the cofferdam was unbolted and floated away. After that, as the caisson was sunk, masonry was added, so that the top was always kept above high water.

In the cut showing the caisson being towed to the site, the wall of the cofferdam can be clearly distinguished from that of the caisson.

Preparatory to launching the caisson, the river bottom at the site was dredged out to a depth of 25 feet, and a fairly level bed was prepared on which it might rest. The caisson was then launched and towed to the site and sunk by filling the crib above the roof with concrete. The latter was carefully rammed in between the steel trusses and the crib timbers, and finished off flush with the top wall of the caisson. The weight of this concrete and a few courses of the masonry pier proved sufficient to sink the caisson to the bed of the river. The next operation was to clear the working chamber of water, and this was done by the simple expedient of forcing air into it until the river bottom had been laid bare. The workmen, who are known by the expressive name of "sand hogs," were then sent down the center shaft and began the work of excavation.



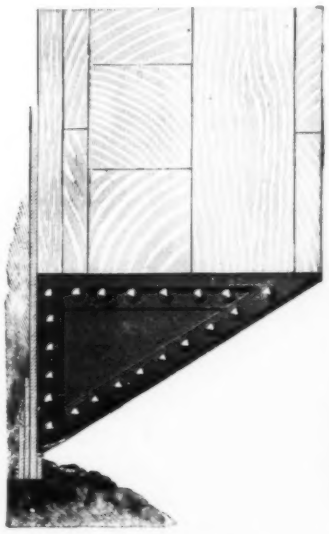
LONGITUDINAL SECTION THROUGH BROOKLYN ANCHORAGE.

The sand was blown out through four-inch pipes by means of air pressure, the column of sand and water in the pipe being rendered buoyant by admitting compressed air through a small pet cock near the roof. A water jet was used to loosen the sand at the mouth of the blow pipe, and it was carried out in a swift and steady stream. When harder material, such as clay or bowlders, was met, it was taken out in buckets through hoists reserved for that purpose. The top of each shaft was provided with an air lock, which was simply a closed chamber with an airtight door at top and bottom. The upper door was opened, the workman entered the chamber, and the door, which opened inward, closed after him. Air was then admitted to the chamber until the pressure rose to that in the shaft, when the lower door, being relieved of pressure, could be opened. The men then descended by the ladder into the working chamber. The operation of the material locks was the same, the wire rope passing through a stuffing box in the outer doors.

As the material was excavated, the caisson sank from its own weight, and the process was carried on until it had been carried down to a solid rock foundation. The next step was to fill up the void represented by the working chamber. For this purpose concrete was sent down the shafts and tamped in place, the filling-in commencing at the walls and being carried on toward the center. The last of the work was done by a single man, who placed the last shovelfuls at the base of the shaft. All the shafts were then filled with concrete, and after this was done the masonry piers were carried up to their full height and capped ready to receive the steel towers. The construction of the New York foundations was carried out under Mr. E. G. Freeman, resident engineer on the New York end of the bridge.

The construction of the piers of the Brooklyn towers was similar to that of the New York piers, above described. The only difference is in the depth of the foundations, which in the case of the second of the two piers were carried down to 107 feet below high water. The caissons were, consequently, deeper than those on the New York side, and it was not necessary to introduce the heavy steel stiffening girders which are a feature in the first-named caissons. The last caisson to be sunk passed through 50 feet of water, 20 feet of sand, gravel and bowlders, 30 feet of hard clay and hardpan, and 12 feet of rock. The rock excavation was rendered necessary by the steep slope of the rock. The rock was stepped out and the lower side of the slope was concreted up to meet the lower edge of the caisson the whole of the working chamber being ultimately filled with concrete and grouted up with liquid cement.

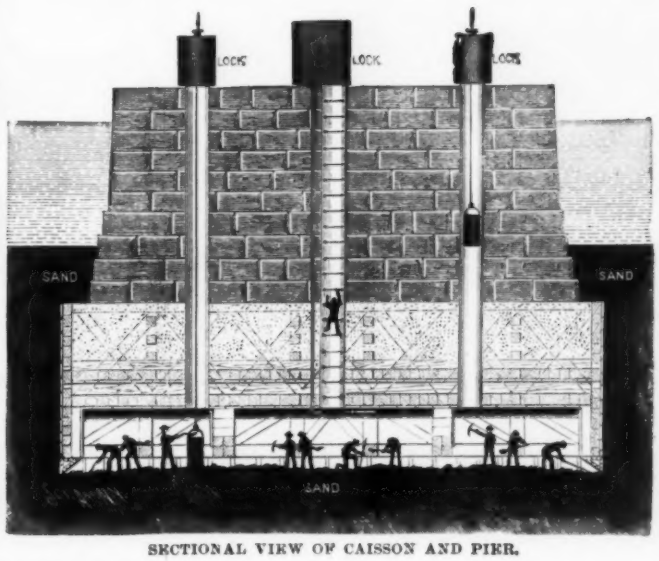
The sinking of this caisson, which was carried out



THE CUTTING EDGE.

TOWING THE CAISSON TO SITE OF BRIDGE.

CAISSON IN POSITION, WITH TEMPORARY COFFERDAM ATTACHED.



SECTIONAL VIEW OF CAISSON AND PIER.

THE BUILDING OF THE EAST RIVER BRIDGE.

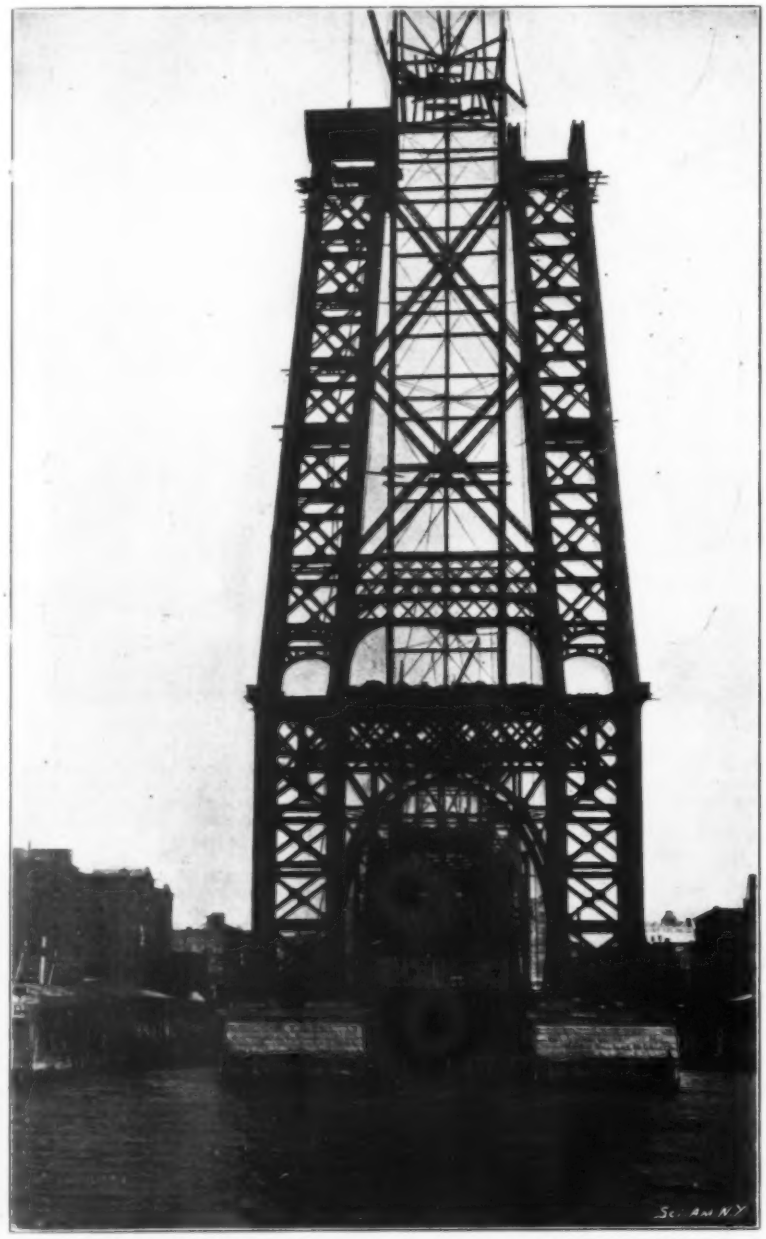
under Mr. James Tabor, was a very rapid and successful piece of work, especially in view of the great depth to which the caisson was carried. The sinking and concreting were done in three months and six days of actual work. The caisson measures 63 feet by 79 feet and contains 74,700 cubic feet of timber and 98 tons of iron, chiefly in the form of drift bolts. Its weight, without the concrete, is 1,965 tons. Above the roof of the working chamber are 6,000 yards of concrete. Above the caisson was a cofferdam 50 feet deep, which contained 29,000 cubic feet of timber and 32 tons of iron. The sinking was accomplished by a gang of men, who worked in shifts of eight hours each down to a depth of 55 feet. Below this the shifts were shortened, being six hours long down to 70 feet, four hours down to 80 feet, two hours down to 90 feet, one and a half hours down to 107 feet. The shifts were latterly divided into two, each of which was only forty-five minutes long. The pay of the men who carried on this arduous work was increased in proportion to the depth, varying from $2.50 for the eight-hour shift up to $3.75 for the short shifts at the lowest level. The air pressure at the 107-foot level was 46 pounds per square inch, yet there was very little sickness, and only one case was serious.

The piers are built of limestone masonry up to the low-water level, above which they consist of granite facing with a limestone backing. They are finished with two heavy coping courses of simple but handsome design, and one pedestal course, consisting of four selected granite blocks measuring 8 feet by 8 feet by 3 feet in thickness.

The Anchorages.

The anchorages for resisting the pull of the cables are extremely massive and imposing structures. They measure 182 feet in width, 158 feet in depth, and 120 feet from the foundation to the coping. Forty feet of the mass is below the street level, above which it rises some 80 feet. The excavation at the Brooklyn anchorage was first concreted to a depth of from 18 inches to 3 feet. Above this was built a platform of four layers of timbers strongly bolted together, while over the platform was laid a great mass of concrete from 6 to 10 feet in thickness, reaching up to high-water level. Above this the masonry commences. It is laid in 3-foot courses, and the blocks are several tons in weight. Altogether there is in one anchorage 44,597 cubic yards of masonry, and the total weight, including concrete platforms, etc., is 125,000 tons.

The total pull of the four cables is 20,250 tons. The anchorage could only move by being rotated about its toe, or by sliding bodily forward. To resist rotation the masonry is massed at the rear (see illustration), the forward half being of hollow construction. Sliding is resisted by the mass of earth 40 feet deep at the toe and by the frictional resistance between the great mass and the earth upon which it rests. The latter is increased by stepping the bottom of the foundation.



TOWER, VIEWED FROM THE RIVER. HEIGHT, 335 FEET.

The pull of the cables is transmitted to the foundation by eight sets of anchor chains, two to each cable. The strands are separated as they enter the masonry and passed around large spools carried at the ends of the anchor chains. The distribution of the strands is shown in the accompanying cut. The chains are made up of steel eye bars 2 inches thick by 9 inches deep. They are carried through curved tunnels in the masonry down to massive anchorage platforms located at the base of the masonry, where it rests on the concrete. The platforms are made of deep and very heavy intersecting girders of steel. There is a single platform for each outside cable and a larger double platform for the two inside cables. The outside platforms are 24 feet by 36 feet and weigh 100 tons each, and the inside platform is 36 by 50 feet and weighs 225 tons. The chains pass down through the platforms and are pinned into massive cast anchor plates of the form shown. These are strongly ribbed to enable them to stand the great pressure to which they are subject. The object of the platforms is to distribute the upward pull of the chains throughout the mass of the masonry. To further distribute the pull of the chains, they are divided into two sets, one above the other. At each link the chains rest upon the masonry, either directly by means of pedestals or by means of short transverse girders, which transmit the pressure to the side walls of the tunnels in which the chains are laid.

Our illustration shows the four anchor plates in the central pit before the anchorage girder platform was built over them. We also show a side platform completed, with deck beams in place ready for the masonry.

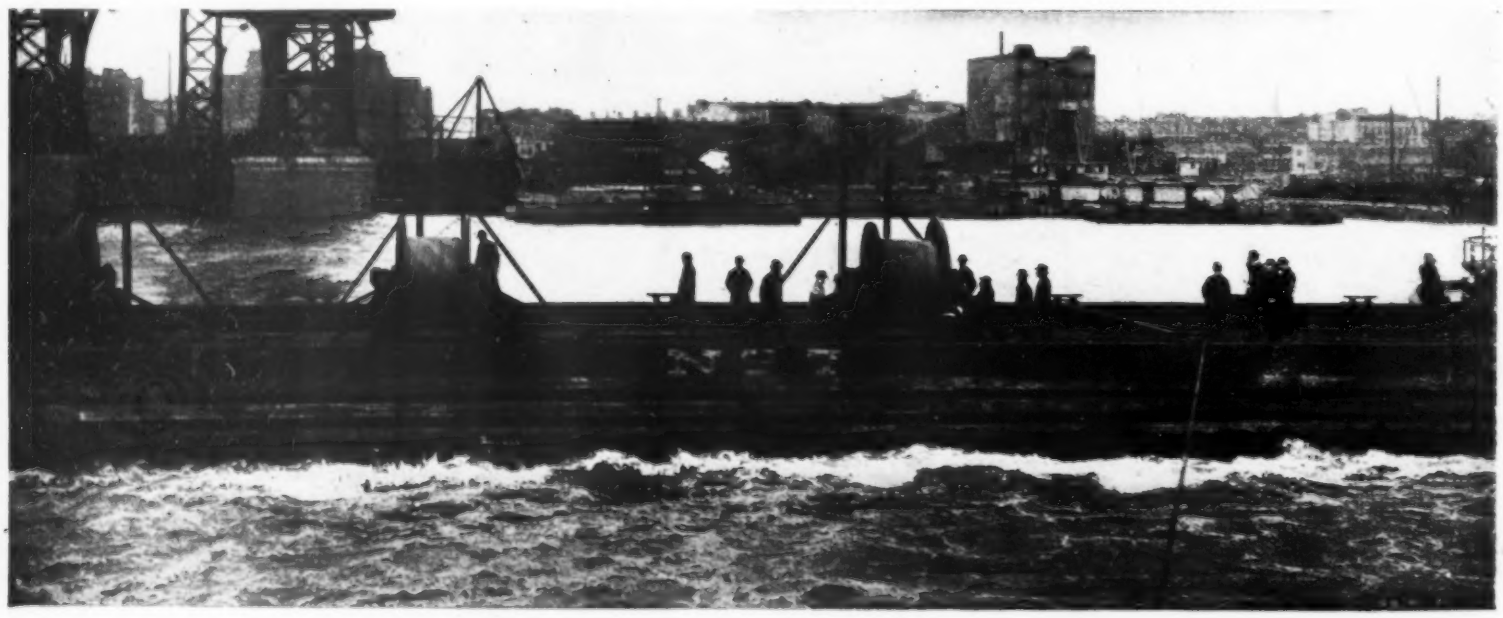
The Cables and Suspenders.

The new East River Bridge is the longest and considerably the largest suspension bridge in existence. Although it is only a few feet longer between towers than the present New York and Brooklyn structure, the main span being 1,600 feet, the suspended structure is considerably wider and more massive, the roadway having a full width of 118 feet and accommodating two steam railroad tracks, four trolley tracks, two roadways, and two passenger sidewalks.

We present on page 23379 a sheet of drawings showing the details of the cables and suspenders. The cables are four in number, and each cable consists of 37 strands of No. 8 steel wire, each strand containing 281 wires. There are therefore in each cable 10,397 wires, or 41,588 in the four cables. The wire is 0.165 inch in diameter and it was required by the specifications to have a breaking strength of 200,000 pounds or more to the square inch, and show an elongation of at least 5 per cent in 8 inches of observed length. It had to be capable of being coiled cold around a rod of its own diameter without cracking. All the wires of each cable strand are spliced so as to form one continuous wire. The splices (see drawings) must have 95 per cent of the full strength of the wire.

Great care was taken to protect the wires from oxidation. As they came from the draw-plates in the mill they were passed through hot linseed oil, and the assembled cables were filled in and coated with a special cable filling. The 281 wires of each strand were laid straight and banded with five or six turns of wire at intervals of five feet, to hold them temporarily in place, the interstices of the cable wires being filled with a special anti-oxidation filling. When the 37 strands that make up a cable were complete, the temporary wire wrappings were removed, all the 10,397 wires were drawn compactly into cylindrical form, and then at intervals of 20 feet the main cable bands (see drawings) were put in place and screwed up so as to take a tight grip on the cable.

In the cables of the Brooklyn Bridge, protection is afforded from the weather by wrapping them with wire. This is not very satisfactory, as the changes of temperature cause the wires to separate, not, as was hoped, evenly, but at intervals of one or two feet. The openings thus formed are sufficient to allow the water to penetrate, and great care has to be exercised to prevent rusting of the cable wires. This is remedied in the East River Bridge by using half round 1-16 inch steel covering plates, which extend from main band to main band. The under half of the cover plate was put on first, and the cable filling, which is a mixture of pine tar and graphite and other ingredients and is absolutely undriable, was packed in between the cable and the shield, while more of it was plastered over the upper half of the cable. The upper half of the cover



TOWING THE FOOT-BRIDGE CABLES ACROSS THE EAST RIVER, APRIL 9, 1901.

plates was then put on and locked to the lower half. Where the main band and cover plates meet, they are overlapped in such a way as to completely shed the rainwater and other moisture (see drawings). At the anchorage the strands of the cables pass through a massive funnel-shaped cable-clamp (see drawings) and around 37 spools or "strand shoes," carried by the ends of the massive eye-bars which lead down to the base of the anchorages.

The suspenders, which are placed abreast at every 20 feet of the length of the bridge, are of 7-strand (wire core) steel wire rope 1¾ inches in diameter. On the Brooklyn Bridge there are four separate suspenders, one at each cable; but in the East River Bridge there are but two, one to each pair of cables, as shown in the accompanying drawings. Each suspender has socketed screw ends, one with a right and the other with a left hand thread, which are joined by a sleeve nut as shown. Each of the main bands of the cable is cast with a half-round saddle to receive the suspender. The upper left hand figure of the drawings shows the method of attaching the floor system to the suspenders. This is done by means of four 2⅛-inch hanger bolts, which extend from the bottom flange of the stiffening truss, at the point of its intersection with the floor beam, to the bottom cast steel shoe or saddle of the suspenders.

Construction of the Towers and Approaches.

The foundations of the towers, four in number, consist, as we have seen, of timber and concrete caissons, sunk in every case until they rest upon bed-rock. Above these are solid masonry piers, two for each tower, the top course of the masonry being 23 feet above mean high water of the East River. Upon each pier are laid four massive pedestal blocks of dressed granite, one at each corner. These blocks are not visible in our engraving as they were boarded up to protect them from disfigurement during the erection of the towers. Upon the pedestal blocks are placed the heavy column pedestals, massive castings which measure 11 feet by 11 feet on the base and about 8 feet by 8 feet on the upper face; they are 3½ feet deep and are strengthened with a mass of intersecting 2-inch vertical ribs.

Immediately upon these pedestals are erected the four massive legs or columns which go to make up each half of the tower; they are square in section, measuring 8 feet on the side at the base, and tapering in the first 20 feet of their height to a square section measuring 4 feet by 4 feet, which they maintain throughout their full height. The massing of metal at the foot of the columns presents an interesting study. They are built up chiefly of ⅞-inch steel plates, stiffened by eight diaphragms which are disposed two on each inner face of the column. The columns throughout their full height, of over 310 feet, are built up of two thicknesses of plate, the total thickness of the metal at the base of column being 1½ inches, and at the top of the column from 1¼ to 1½ inches. The two thicknesses are thoroughly riveted together and the stiffening diaphragms which are worked in at the base of the column are replaced in the upper 4-foot section of the tower by eight built-up Z-bars, two on each interior face of the column. The distance, transversely of the bridge, from center to center of the columns is 24 feet, and they are spaced 40 feet apart, measured in the direction of the axis of the bridge. The four columns of each tower are carried up vertically and parallel as far as the level of the roadway.

Above the roadway the towers have a sharp inward batter, the inclination being 14 feet in a height of 215. The four columns are strongly braced together, the bracing being built up of heavy angles and tie-plates. Immediately below the floor of the bridge a system of massive lattice-bracing is run entirely around each tower, and extends also between the towers themselves. Similar lattice trusses extend from tower to tower between the inner legs above the roadway. Additional stiffness and a pleasing architectural effect is gained by the construction of a stiffening arch immediately below the roadway. The saddle castings, each of which is about 7 feet 8 inches in width by 19 feet in length, and weighs 32½ tons, are placed immediately over the legs of the columns, a system of heavy column girders, 7 feet in depth, being interposed between the columns and the saddle castings. These girders extend transversely from tower to tower, and serve to give great rigidity at this point.

The erection of the towers was carried on by means of timber false-work. This false-work rested upon the masonry piers and was stiffened by being fastened to the tower itself and by a liberal use of wire cables with turnbuckle adjustments. The lighter material was brought to the tower over a trestle which was built out from the shore; while the heavier material, which in the case of the column footings weighed as much as 12 tons, and in the case of the bottom tapered sections of the tower, as much as 24 tons, was brought to the work upon lighters and picked up and placed in position by means of derricks, which at first were operated from lighters, but subsequently were rigged upon the top of the tower false-work.

Simultaneously with the erection of the towers, work was being pushed on the construction of that portion of the bridge which lies between the anchorages and the towers. Unlike the Brooklyn Bridge, this portion of the roadway is not supported from the cables.

FOOT-BRIDGES FOR TEMPORARY CONSTRUCTIVE USE.—VIEW FROM TOP OF MANHATTAN TOWER.

After the suspender was laid over the upper main band saddle and beneath the bottom shoe, and its ends coupled by the sleeve nut, the proper load was thrown upon the suspenders by means of a temporary knife-edge adjusting block. The nuts shown in our drawing were then screwed up and the adjusting block was removed. The smaller drawing shows a suspender at the center of the span, while the larger view shows a long suspender near the towers and the method of connecting up the lateral ties.

The saddles are massive ribbed castings of the form shown in the drawings, each of which weighs over 32½ tons. They are 7 feet 8 inches wide by 19 feet long and 4 feet deep at the center. The cable rests in a recess struck to a 21-foot 6½-inch radius, the recess being semi-octagonal in cross section. The saddles are supported upon twenty-two 15-inch steel channels, laid parallel with the axis of the bridge, and the movement of the saddles is provided for by the interposition of forty 2¼-inch steel rollers. In erecting the cables, the saddles were placed 6½ inches back toward the anchorages from their final position. When the load of the suspenders and floor system was added, the saddles were drawn forward 6½ inches to their normal position over the towers, except on the Manhattan tower, where the fire caused the saddles to slip forward prematurely.

The trusses at their inshore end rest upon the masonry anchorages, but at the bridge they are supported upon massive rocker bents which rest by means of hinged bearings upon heavy girders built into the structure of the tower. Midway between the towers and the anchorages is an intermediate tower upon which the trusses rest by means of a combination hinge-and-roller bearing. The main span between the towers is, of course, carried by the main cables, except for the first 100 feet or so at the tower, which receives a cantilever support from that portion of the truss which extends from the main tower to the intermediate tower. Unlike the stiffening trusses of the Brooklyn Bridge, the new East River trusses are not cut at any point, or contain any slip-joints, but are continuous from anchorage to anchorage; moreover, they are not anchored rigidly either to the towers or to the anchorages. As we have already pointed out, they are provided with roller bearings at the anchorages and at the intermediate towers, and with rocker shaft bearings at the main towers; consequently, being higher at the center than at the ends, they expand evenly and freely from the center toward the anchorages on either shore.

Stringing the Cables.

For the construction of the cables, temporary working platforms were built from the anchorages to the

top of the towers and between the towers. These platforms were for the accommodation of the workmen in handling and adjusting the wires. The platforms were double-decked, the upper deck being used for the construction of the separate cable strands, which were lowered as they were completed through a distance of 15 feet to the lower platform, where they were assembled in the cable. The cable wires, which are about 3-16 of an inch in diameter, were made at the mills in 4,000-foot lengths and reached the site of the bridge on 7-foot wooden reels. Each reel contained 24 of these lengths of wire, which were coupled at the ends with sleeve nuts, the joints being designed to give the full strength of the unbroken wire. The reels of wire were placed on each anchorage in bearings carried on wooden frames, which were laid in the lines of four cables. At each end the cables had to be connected with a series of massive eye-bars, which extend down through the anchorage and are bolted to a huge anchor platform at the base of the masonry. The connection consisted of massive shoes round which the wires of each strand were carried, the shoes being themselves pinned in between the ends of the I-bars, as shown in our illustrations.

The method of building each strand was as follows: The end of a wire was taken from one of the spools and made fast to the strand-shoe, and then the wire was unwound from the reel sufficiently to form a bight, which was passed around a 3-foot sheave, attached to an endless carrier cable which extended from anchorage to anchorage across the towers. The two parts of the carrier-cable were arranged as near as possible to lie in the plane of one of the main cables, and each part had attached to it a carrier sheave, in such a way that while one sheave was carrying its strand wire from New York to Brooklyn, the other was carrying its own strand wire from Brooklyn to New York. It will be evident from what we have said that each time a sheave traveled across the river, it drew with it a double wire. As a similar arrangement was provided for the other two cables, eight wires altogether were being simultaneously carried across the river when the whole system was in operation. When the carrying sheaves reached the opposite anchorage, the bights of the wires were removed from the sheaves and slipped over the strand-shoes. The rate of progress of the work was about 50 wires in each strand in ten hours, or a total of about 400 single wires each working day. When the end of the coil of wire was reached, it was placed in a vise opposite to the end of the next coil of wire and the two were connected by a sleeve nut. A perfectly even tension was secured in each wire by adjusting it so that it conformed to the curve of a guide wire, which had been accurately adjusted in position by the engineers.

In putting up the strands, the apportionment of labor was as follows: There were three men on each anchorage to look after the reels, put the bights on and off the carrier-wheel, splice the wires, etc. There were three men to handle the wires at the top of the tower, until the strand was ready for lowering into the saddle, whose duty it also was to see that the wires were hung exactly in the curve of the guide-wire already referred to. There were also three men placed between the anchorage and the top of the tower, who, as soon as the tension was adjusted, clamped the wire to the strand. The adjustment of the wire between the towers was done by seven men, and the adjustment of the wire between the other tower and the anchorage was accomplished in a similar manner to that described already. Care was taken in placing the bights of the wire around the strand-shoes, to lay them in regular courses on the shoe, so that they would correspond with the position of the wires at the other end of the strand on the opposite anchorage.

As each strand was completed, its end shoe was turned from the horizontal to a vertical position and allowed to slide forward toward the tower, thereby lowering the strand to the final position of the finished cable; the shoe being finally placed in position between the anchor chain eye-bars and held in place by its end pin. The thirty-seven strands in each cable are arranged in a hexagonal cross sectional form, five strands lying on each side of the hexagon.

BINDING WIRE STRANDS INTO CABLES.

COMPACTING WIRES INTO CABLES AT THE BROOKLYN ANCHORAGE.

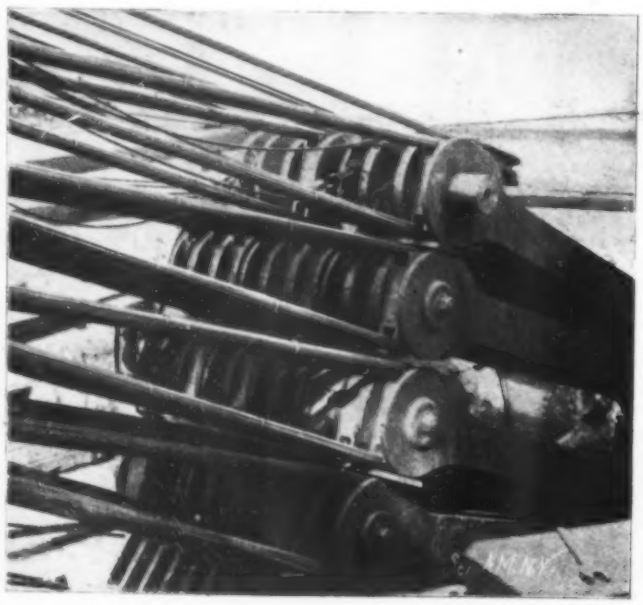
Floor System of the Bridge.

In comparing the greatest bridges of the world—and it seems as though we can only arrive at a correct idea of the proportions of one of these great structures by expressing it in terms of some other one—it is impossible to say of any particular bridge that it is, in the total, the greatest of its kind. One bridge may have the longest single span, and another the greatest number of extremely long spans; to another may belong the distinction of having the greatest carrying capacity, while a fourth may be distinguished by the magnitude of certain parts, such as the foundations, which are entirely hidden from view. In respect of the length of its main span, the present Brooklyn Suspension Bridge is practically the equal of the new East River Bridge, the new structure having a span of 1,600 feet between towers and the older bridge being five or six feet less. In over-all measurement, indeed, the Brooklyn Bridge greatly exceeds the new structure, the distance from anchorage to anchorage being 3,455 feet 6 inches, whereas the distance between anchorages of the East River Bridge is several hundred feet less than this. Although the total length of the steel structure of a bridge is what we might call the most spectacular feature of its measurement, the true test of the capacity of these modern, long-span bridges is the width of the floor system, or its capacity for traffic. Judged on this basis, the new East River Bridge is considerably the largest structure of its kind in the world.

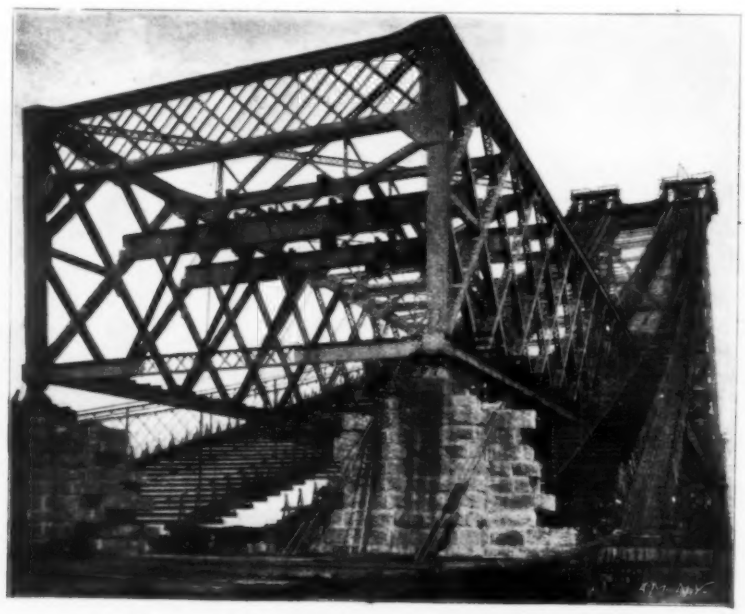
With a view to giving the reader an adequate impression of the carrying power of the new bridge, our artist has prepared the cross-sectional view which is found on page 23380. The section is supposed to be taken at a point about a third of the way across the main span, starting from the Brooklyn tower. As the parts of the bridge at the point of section are shown to exact scale, the drawing not merely affords an admirable perspective view of the finished structure, as it will appear to a passenger in crossing the bridge, but it shows with great detail the exact proportion of the various members, the method in which they are assembled, and the functions which they severally perform. For purposes of comparison it may be mentioned that the extreme breadth of the suspended structure of the Brooklyn Bridge is 85 feet; whereas the extreme width of the floor of the new East River Bridge will be 118 feet. The total width of the latter is about evenly divided into five separate roadways. Of these, the center roadway, which is devoted to the elevated cars, contains two tracks, one for east-bound and the other for west-bound traffic. On each side of the elevated tracks are two street-railway car tracks, while beyond these on the extreme outside of the bridge, are two carriage roadways. Above the street railway tracks are two platforms, each divided at about its center by an iron railing. Of the four roadways thus formed those on the outside are devoted to bicycle traffic, while the inside roadways are given up to foot passengers.

The great load of the suspended roadway is carried by four steel wire cables, in each of which there are 10,397 wires, 0.165 inch in diameter. The wire has a breaking strength of 100 tons to the square inch. The floor system is suspended from these cables by steel wire ropes, 1¾ inches in diameter, which are carried up and over steel saddles clamped upon the main cables. Each suspending cable is continuous; that is to say, it is carried over the cable saddle and below a bottom suspension saddle, the two ends being coupled in a sleeve. Two heavy inverted steel U-bolts depend from each bottom suspension saddle and are bolted beneath the covering plate of the bottom cords of the trusses.

If the floor system of a suspension bridge were at all times equally loaded from end to end, there would be no danger of a deformation of the cables, and the floor would maintain a true surface. But since the traffic is liable to be concentrated or "bunched" at one or more positions on the bridge, it is necessary to stiffen the floor system to resist the vertical distortion which would otherwise result. This stiffening is afforded by two massive stiffening-trusses, each 40 feet in depth, which extend entirely across the bridge from anchorage to anchorage. These trusses are located immediately on the outside of the street railway tracks, and lie in a vertical plane between them and the carriageways. The bottom chord of the truss is of the same depth as the floor system into which it is built, and with which it is firmly incorporated. The floor proper of the bridge consists of a series of transverse plate-steel girders, 5 feet in depth, which extend entirely across the floor from side to side. These girders are placed 20 feet apart and the gaps between them are bridged longitudinally by lines of plate-steel



CONNECTION OF CABLE STRANDS TO ANCHOR CHAINS.



LOOKING UP THE TEMPORARY FOOTWAYS FROM THE ANCHORAGE.

stringers, of about half the depth of the floor beams. There are twenty of these lines of stringers counted across the width of the bridge, and they extend entirely throughout the structure from end to end. The load of the roadways is carried by the overhanging, cantilever-like, ends of the floor beams, and the middle portion of the floor beams between the stiffening trusses is supported at two intermediate points from a series of overhead trusses, which are built in between opposite panel-points of the top chords, at every 20 feet of the length of the bridge. The advantage of this method of construction is that it saves weight, and also enables the floor beams to be made many feet shallower than they would have to be were they not thus supported.

The stiffening trusses are constructed on the riveted system in preference to the eyebar system, which was at one time so greatly in vogue as to be considered the typical American construction. As a matter of fact, in the whole of this bridge, there is not, as far as we know, a single eyebar used, except at the anchorages, where eyebar chains extend through the masonry to take hold of the anchorage platforms. The web members of the stiffening trusses are arranged on the triple intersection plan and they consist, as do also the members of the lateral system, of heavy angles placed back to back and latticed together. The bicycle and foot-passenger platforms are carried upon plate steel floor beams which are supported at their outer ends by the web members of the stiffening trusses and at their inner ends are riveted to the vertical ties connecting the overhead trusses with the floor beams.

In a suspended structure of this great span, presenting such a large total area to the pressure of the wind, it becomes necessary to make special provision to resist wind stresses. As far as the floor system is concerned, this provision consists of a heavy horizontal system of trussing between the top chords of the stiffening trusses, while in the plane of the floor of the bridge sufficient resistance to lateral distortion is afforded by the manner in which the longitudinal stringers are riveted intercostally between the floor-beams; the tensional stresses, due to a wind blowing transversely across the bridge, being resisted in the leeward half of the floor by the stringers and the bottom chord of the stiffening truss, and the compressive stresses being similarly resisted by the stringers and bottom chord of the windward half of the floor system. The wind stresses are also resisted by the "cradling" or inclining together of the cables.

The Disastrous Bridge Fire.

Near the close of last year the new bridge was imperiled by a fire which might have wrought irreparable damage to the structure; and, as it is, has left its everlasting mark upon this noble work in the shape of an ugly enlargement of the third cable on the New York tower. To understand the nature of the accident, it may be as well to explain to what point the work of erecting the East River Bridge had progressed. All the wires of the four great cables, each 18½ inches in diameter, were strung and the bridge gangs of the company who were building the cables had been engaged wrapping the cables with a protective covering designed to prevent oxidation; and in covering the wrapped cables with the sheet-steel plates, which form the outermost covering and shed the water freely in rainy weather. The greater part of this work had been done, and the saddle clamps on which the double suspenders at each panel point of the bridge are supported had, most of them, been put in place and the suspender cables slung over them. The foot-bridges were carried upon four wire cables 2¼ inches in diameter, each of which extended in one length over the towers from anchorage to anchorage.

At the top of each tower, 335 feet above the water, a broad timber platform had been erected, which served both as a working platform for the workmen and for the temporary storage of material used in construction. There had also been erected over each tower an extremely heavy framework of 12 x 12 timbers, which was used in temporarily carrying the strands during the stringing of the cables. On the towers at the time of the accident was stored a considerable amount of waterproofing material, a composition made of oxidized linseed oil, asphaltum, and varnish gums. The fire broke out about five o'clock in the afternoon, and under the influence of a fresh breeze rapidly gained headway, and enveloped the whole of the platforms and timber structure at the top of the Manhattan tower in flames. After the fire had been in progress for a considerable time, the cables carrying the footbridges became so heated that they parted at the towers, with the result that these cables with their timber platforms fell back toward the Manhattan anchorage and toward the Brooklyn tower, much of the wreckage falling into the river. One of our illustrations shows the distorted wreck of the footway as it appeared the morning after the disaster, suspended above the East River. The fire burned with great fierceness, and the 335-foot tower showed up against the black sky like some gigantic torch, affording a pyrotechnic display of weird and spectacular beauty. The fire department made a determined effort to get their hose to the top of the tower; but the work was rendered very difficult by the great height, and by the fact that masses of burning timber and red-hot bolts were continually falling through the towers. Great fears were expressed lest the heat had risen to a point at which it had wrought

STRINGING THE WIRES.

permanent injury to the main cables, an event which might have necessitated the taking down of the cables and their rebuilding at a cost of a great sum of money and with the loss of a year or two of valuable time. It was therefore with great relief that, on inspecting the main cables and the saddles, it was found that no material damage had been done to the tower and the saddles, and that only the outer layers of wires in the cables had been injuriously affected by the heat. At first thought it may seem strange that a fire which was sufficient to heat the footbridge cables to the point of rupture should have had no greater effect upon the main cables; but it must be borne in mind that the former were carried upon timber saddles and were consequently exposed to the fiercest heat of the conflagration. Moreover, they were only 2¼ inches in diameter, and their mass was so small, relatively, that they quickly became raised to the temperature of the fire. The main cables, on the other hand, because of their great mass, were able to absorb, transmit, and radiate the heat in such quantities, that only the outer layers of wire were raised to a temperature at which they were annealed and their tensile strength reduced. In absorbing and dissipating the heat, they were assisted by the great mass (30 tons) of the cast-steel saddles in which they rested.

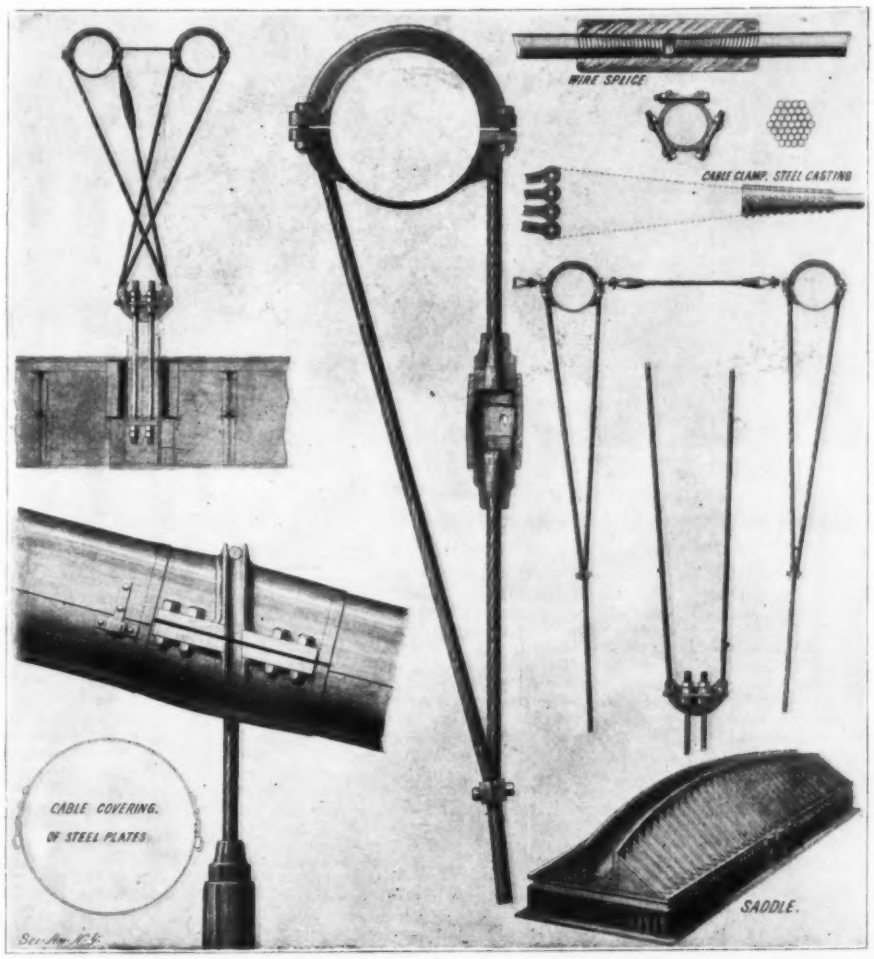
On removing the covering plates and waterproof wrapping, it was found that the outer wires for a distance of from 20 to 30 feet across the saddles were warped. This effect can be seen in one of the accompanying photographs, which was taken at the summit of the Manhattan tower the morning after the fire.

Repairing the Cables.

The report of the Board of Engineers appointed to decide what repairs should be made to the cables found that the annealing of the wires by the heat of the fire left one of the cables, known as cable A, 2.5 per cent weaker than it was before the fire, while cable B was weakened by 6.5 per cent of its original strength. They suggested a method of repairs or reinforcement which restored cable A, so that it is only one-quarter of 1 per cent weaker than it was before the fire, while cable B lost 2 per cent of its original strength.

Each cable contains thirty-seven strands, and each strand is made up of 208 wires, making a total of 7,696 wires in each cable. The specifications called for an ultimate strength of 200,000 pounds or more to the square inch, but this strength actually ran much higher, being from 8 to 10 per cent greater than the specifications called for, the ultimate strength being from 216,000 to 220,000 pounds to the square inch. The result of the heating of the wires, as we have said, was to anneal and also to lengthen them, the heated wires, after the fire was over, being more or less bowed out from their proper position and not lying parallel with the mass of the cable. The annealing resulting from the fire reduced the strength so greatly, that, in extreme cases, the strength amounted to only 80,000 pounds to the square inch. The heat annealed the wire more or less completely for a depth of four layers. Thus specimens cut from the outer layers showed that while the uninjured wire had a strength of 223,800 pounds to the square inch, the most injured portions of the burnt wires showed a breaking strength of only 89,900 pounds to the square inch. The reduction of strength decreased in the second, third, and fourth layers, where it fell from 234,000 pounds to the square inch to 210,500 pounds to the square inch, which, by the way, is 10,500 pounds per square inch greater than the specifications called for. A count made of the injured wires showed that 500 had been affected in cable B and 200 in cable A.

As the injury took place at the bend of the cables over the saddles, where the strength should be the greatest, it was decided, after the wires had been spliced, to add 25 additional wires to cable A, and 200 additional wires to cable B. As the ends of these wires could not connect with any of the wires in the cables, these being spliced to their own new sections, it was decided to attach these additional wires to the cables by friction. A series of steel bands was clamped around the cables, at varying distances from the saddle, to the adjoining suspenders on either side, and a certain number of additional wires were attached to each clamp. There were three bands on each side of the saddle on cable A and eleven on cable B. Thus twenty wires run to the outermost band furthest from the saddle and adjoining the first suspender; then twenty wires were attached to the next band; twenty to the next, etc. On cable B the first band covers 200 wires, none of which are fastened to it; the second band covers 180 wires, twenty of which are fastened to it, etc. Furthermore, it has been recommended that fireproof flooring be used throughout the whole length of the bridge. It is gratifying to know that the injury to the cables of this magnificent structure was such that it could be entirely repaired, the bridge as repaired being indeed stronger in its cables than was called for by the contract.



DETAILS OF CABLES AND SUSPENDERS.

Building the Floor of the Bridge.

When the contractors started to build out the roadway from the towers, the main span between these towers consisted of the four great cables with steel-wire suspenders hung from them at intervals of 20 feet. At the bottom of each suspender, as they were left by the cable contractors, were four heavy steel bolts, complete with nuts at each end of the bolts. The length of the suspenders had been so graduated that the bottom of the suspender bolts was in proper relation to the curve which the floor of the bridge was designed to assume when the whole load of the completed floor system is hung on the suspenders. The process of erection consisted in first building out the bottom chords of the two stiffening trusses in sections, and bolting them to the suspender bolts mentioned above, and then putting in place and bolting up between the chords the network of floor beams and stringers. For carrying on this erection, the contractors built two large travelers, each carried on four axles 20 feet apart, with a stiff-leg derrick at the front end of the traveler. The tracks for the latter were laid above the first line of longitudinal stringers inside the

bottom chords of the truss, and as the floor framing was built up, the traveler moved forward over it. Across the top of the front bent of the traveler was a strong, transverse lattice girder, at the center of which was pivoted the 62-foot boom of the derrick, and the foot of the derrick mast. The two stiff-legs were carried back to the last bent of the traveler as shown, and when a heavy load was to be lifted, the bottom frame of the traveler was clamped to the upper flanges of the floor stringers.

The material for the floor system was brought on scows to a landing near the foot of the towers, hoisted on to a tramway, run out to the front of the base of the towers, and then hoisted to the level of the floor system by a crane which placed it on a trolley, the trolley in turn carrying it out to the erecting traveler on the bridge. The chords were built out in 60-foot sections, representing each a length of three panels, the weight of each section being 25 tons. The floor beams, which were the next heaviest single load, weighed 10 tons each. As soon as the 60-foot chord lengths with the floor beams and stringers between them had been bolted up, the traveler moved forward 60 feet, and another section of the floor was built out, the operation being repeated until the two gangs of workmen met at the center of the span. The whole 1,600 feet of floor, weighing no less than 2,750 tons, was erected and bolted up in six weeks' time, a most creditable performance, and a rate of speed which, if it had been observed on some other portions of the work, would have hastened the final completion of the bridge materially. The next operation was to erect the 50-foot stiffening trusses, the lateral carrying trusses for the floor beams, and the various details of the lateral wind truss system. Second only in importance to the erection and bolting up of the floor and truss was the work of riveting, which followed close after the first erection. For riveting, an air-compressing plant was built on the Brooklyn shore, and a 6-inch main was laid across the bridge.

To facilitate erection, and to insure that when the final riveting up took place the bridge would hang at its proper designed curves and level, the contractors drew up a blue-print showing where the material of the trusses and lateral system was to be placed along the bridge ready for erection. Every one of the many thousands of angles, posts, girders, etc., was numbered, and had its place assigned it somewhere on the great 1,600-foot span. Each piece was laid upon the floor in the reverse order in which it was required, so that when the erectors started work there was no time lost in hunting for particular sections, but they were right at hand ready to be put in place, and incidentally performing the important function of loading the flexible structure to the true lines, in which it was inflexibly held when the stiffening truss had been erected and riveted up.

Figures of Quantities and Cost.

An account of this great structure would be incomplete without some statement of the great quantities and cost of the materials of construction. In each anchorage there are 1,500,000 cubic feet of timber, 10,000 cubic yards of concrete, 45 000 cubic yards of stone masonry, and 1,700 tons of anchor steel. Beneath the Manhattan anchorage are 3,500 piles; the Brooklyn anchorage stands on the natural sand. There are 12,000 tons of steel in the towers and shore spans; 5,000 tons of steel wire and cable castings; 18,000 tons in the steel approaches; and 8,000 tons in the suspended structure of the main span.

The contract prices were as follows: New York tower foundation, $373,463; Brooklyn tower foundation, $485,082; the anchorages, $1,570,000; steel towers and shore spans, $1,221,726; cables and suspenders, $1,398,000; the approaches, $2,411,000; the main span suspended system, $1,123,400. The total cost of the Bridge, including land, is over $20,000,000.

The Engineering Staff.

In concluding our description we take pleasure in bearing testimony to the unvarying courtesy of the engineering staff in giving the SCIENTIFIC AMERICAN every facility, during the erection of the bridge, in preparing the many illustrated articles on the subject that have appeared during the past seven years. Mention should be made of L. L. Buck, the chief engineer; O. F. Nichols, principal assistant engineer; H. D. Robinson and K. L. Martin, resident engineers, in addition to others who are mentioned incidentally during the preceding article.

MECHANICS AS EXEMPLIFIED BY THE ANIMAL FRAME.

By PROF. DR. OTTO FISCHER.

FROM man's earliest knowledge of it, physiology, organic and inorganic, has furnished the greatest variety of mechanical problems. For instance, it furnished the incentive to mechanical respiration, mechanical digestion, mechanical circulation of the blood, a mechanical development wherein, of course, the mechanical conception is, in part, endowed with a more general philosophical meaning.

Physiology has, moreover, not only taken counsel of the science of mechanics in the explanation of the bodily form, and many arrangements in the structure, at certain periods of plant and animal organism, but also for the better understanding of the functioning and capacity for work of the same.

The principal field for the application of mechanics in physiology is, at all events, *the study of the limb-movements* of the human as well as other animal bodies, be it that the same are applied to locomotion or to the accomplishment of other forms of work. Physiological mechanics, in the above-described restricted sense, finds the subjects for its inquiry already prepared in nature. But before it can advance to the investigation of the movements of the living body, impelled by external or internal forces, more especially muscular force, it must acquire a precise knowledge of those peculiarities of the individual parts of the body, which, above all, characterize the mechanical relation of the parts to the motive force.

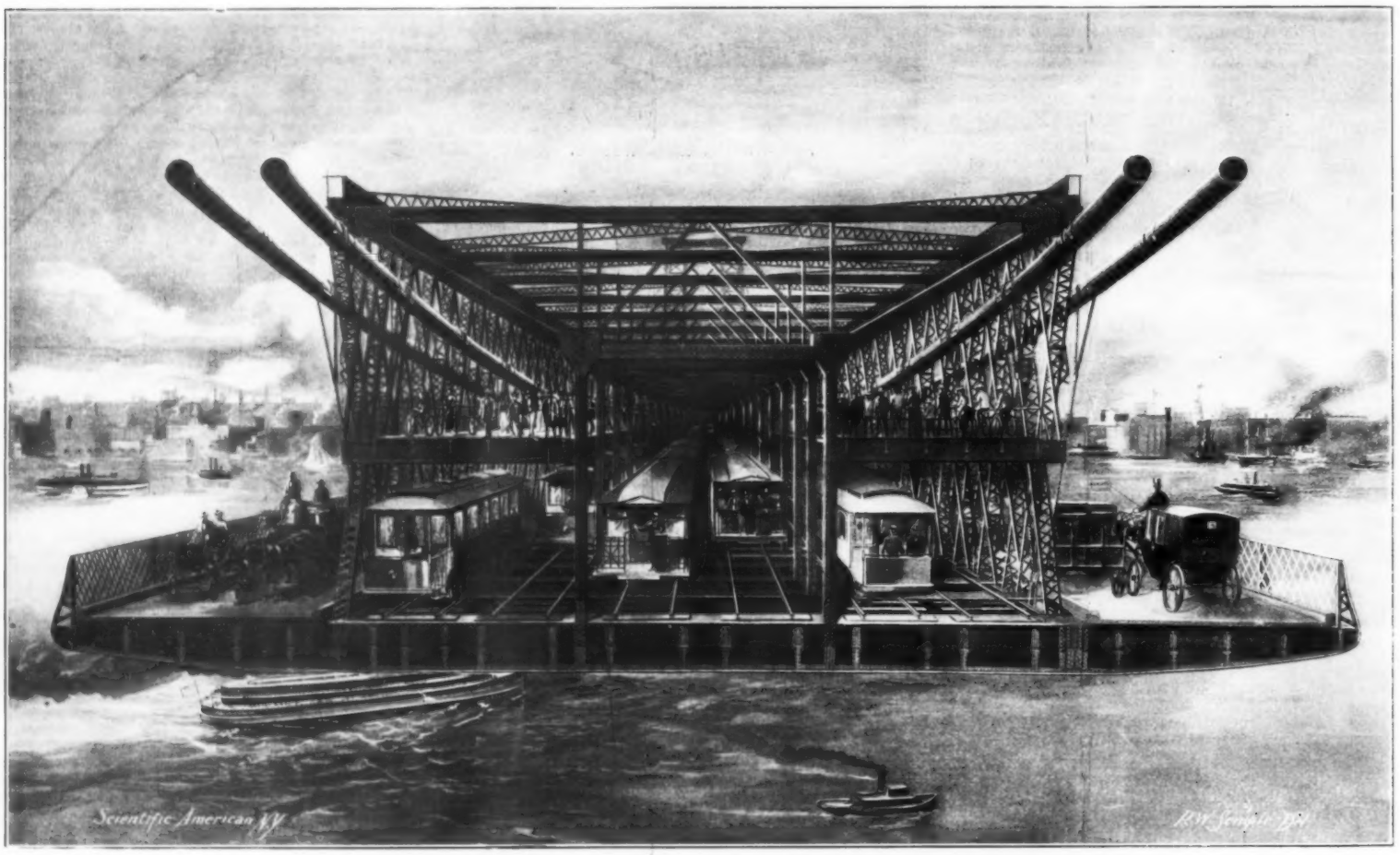
In the beginning it is necessary to determine such quantities as the dimensions of the body, its weight, the center of gravity, and the so-called moment of inertia, which depends upon the division of the mass about the center-point; all these items are applicable to the living body. Furthermore, there must be made a thorough search into the manner of articulation between neighboring parts of the body, as well as concerning the joints themselves and their possible motions. The human and animal bodies have often been compared to machines. In the joints, however, it is already shown that they differ materially. On the one hand, we have in the animal body joint-surfaces which are to a certain degree deformable, i. e., subject to enforced change, since the articular ends of the bones in the larger joints of the human frame are covered with a cartilage up to a thickness of 5 millimeters, which is deformed, or suffers compression, under a load; whereas in a machine the joints are purposely made very strong and of the material best calculated to withstand the wear without give or loss of motion. Again, there is much greater freedom in the movements of the joints of the human and animal frames. Since the purpose of most mechanical joints consists in forcing, by the form of the joint, the surfaces of the two connected parts to move in a determined relation to each other, the difference in the animal organism is more apparent, because in most of the joints no such compulsion is present, at least not in the form of the joint itself. As is well known, in both the shoulder and the hip joint we are able to move our extremities in the greatest variety of ways toward the trunk. The difference of the two combinations is more patent when we consider the relative motions of two separated parts, parts not joined directly together. In a machine, even parts of the organization widely separated are compelled to move in a previously determined relationship one to the other, whereas in the human organism, the further the parts are separated, the greater the freedom of movement. For example, the movements of the hand, within the limits prescribed by the length of the bones of the arm, are carried on toward or from the trunk as if it were free from the body altogether.

In spite of this apparent freedom from restraint, we are nevertheless in the position to command at any moment a certain movement of the part. This compulsion is not forced upon the hand by the form of its joint at the shoulder or the elbow, but by the governing force, *our will*, transmitted to it by the way in which we excite the muscles connected with the joints. We are able therefore at any moment to change our body at will in the greatest variety of ways, *into a certain machine*.

From this viewpoint the human body resolves itself into a machine of the greatest versatility; a great complex of different machines. That this versatility is not gained at the cost of perfection in the mechanical performance of the individual acts, is a matter of daily experience.

The radical difference between the organic and mechanical joints affords the kinematic investigation of physiological mechanics, as far as it relates to the articulation of the joints, its characteristic stamp; it demonstrates that we not only find a much greater variety in the forms of the articular surfaces of the organism, but that we are also capable, at times, of movements in an organic joint that would be utterly impossible in a joint of stiff, unpliable metal.

The chief problems of physiological mechanics have to do with the exercise of motion by the members under the influence of exterior or internal forces. These



Extreme Breadth, 118 Feet. Depth of Trusses, 40 Feet. Length of Main Span, 1,600 Feet.

THE FLOOR-SYSTEM OF THE NEW EAST RIVER BRIDGE.

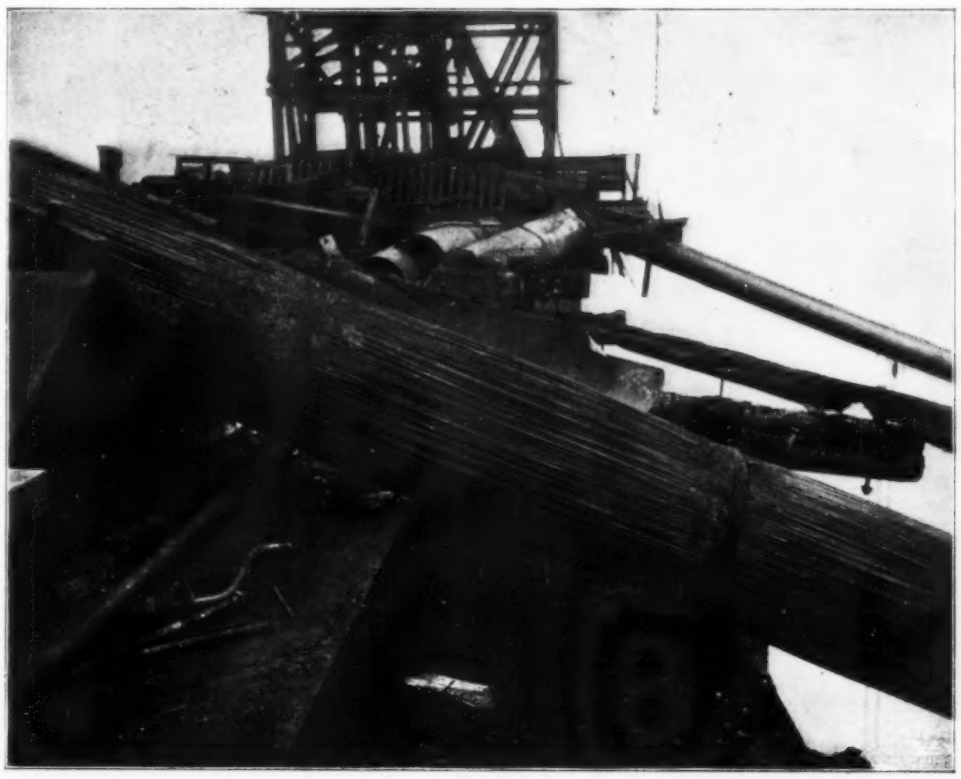
kinetic problems are divided into two groups. In the first group, the powers or forces are accepted as known, and the problem for solution concerns the motions which these forces create in the living organism. Under this head, and above all others, belong the researches into the effect which the single muscle of the human or animal body exerts by its contraction at a certain determined tension. As valuable as these inquiries may prove for the more perfect comprehension of the function of the individual muscles, as far as physiology is concerned they possess more of a theoretical than a practical value, for up to the present it has neither been possible to determine the tension of a muscle in the living body nor to estimate its contractive powers under electric excitement.

The second group of kinetic problems for physiologico-mechanical solution presupposes the condition of mobility in the living body during the course of the motion, and inquires into the muscles which, in conjunction with internal forces, cause the motion.

These tasks, in which occur also purely static problems that refer to the complete quiescence of the human body, are of considerable value to physiology.

While the solution of problems under the first group often presents insurmountable difficulties, those of the second group are always solvable in principle as soon as the condition of motion of the body for the whole course of the motion to be examined has been empirically determined with sufficient exactness. To this end instantaneous photography renders invaluable services. For a kinematic analysis of any given motion of the human or animal body it is sufficient to fix, as closely as possible, the superficial motion of single suitably chosen points of the different parts of the body. This is best accomplished by making these points intermittently self-luminant by means of electricity. For this purpose there may be arranged on the desired points of the body a line of wire severed at many places, which will produce sparks, or small Geissler tubes, having a current from an induction coil passed through the whole. The necessary interruption of the current may be effected by means of a tuning fork, which will make and break the current at exact intervals of time.

To carry the investigation further, provide a totally dark room in which the subject shall be placed, and from any number of sides let the motion with its illuminated points be photographed by a number of ordinary cameras at the same instant. This can be done without attaching any expensively constructed shutters to the camera, for the points are all illuminated at intervals equal to or less than those provided by the quickest shutter, being at the same time continuous. Since in this case the interruption of the exposure is, to a certain extent, placed in the object itself, we obtain for the kinematic analysis absolute isochronism in the series of pictures taken from different points. There remains now only the exact measurement of the series on each plate in order to transfer the whole procession of motion to a superficial chart or system of co-ordinates, and upon the basis of this co-ordinate system undertake a kinematic analysis. The problems of the second group which have so far been taken in hand relate mostly to the progression of man or animals. Those studies which relate specifically to the progression of man come down to us from the investigations of the brothers William and Edward Weber. They were the first to fix, as exact as possible, with the means at their command, the laws relative to the various gaits, walking, running and jumping. Since instantaneous photography, then unknown, could not aid them, they were compelled to supplement the results of their measurements with many hypotheses. Upon this basis they nevertheless built up their theories of the walk, the double-quick, and the lope, which afford at least a passable representation of the kind of external forces that influence the motion of the common center, and also of the mutual effects of the trunk and the extremities upon each other. Because the character of their kinematic theories was all too hypothetical, and they have of late proven themselves untenable, they were unable to proceed with the examination of the activity exerted by the individual muscles. At all events, the Weber "Mechanics of the Human Walking Organs" stands as the first attempt to explain the special sequence of motion of the human body through the exact means of mechanics.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.



SUMMIT OF THE MANHATTAN TOWER, SHOWING INJURED PORTION OF ONE OF THE MAIN CABLES.

REPORT OF THE SECRETARY OF AGRICULTURE.

THE annual report of the Secretary of Agriculture has been published. It begins with a discussion of the educational requirements of the research work of the department. Although the department has availed itself to the fullest extent of graduates of the agricultural colleges, it has been necessary, in view of the

THE NEW EAST RIVER BRIDGE AFTER THE FIRE. THE MANHATTAN TOWER WHERE THE FIRE OCCURRED IS IN THE FOREGROUND.

rapid development of the work, to secure competent men wherever they could be found. In the training of specialists for its various lines of work, the department has become practically a post-graduate institution. Mr. Wilson, in illustration of this fact, reports the admission to the department since 1897 of 496 students; 249 of these are still in the department, not less than 132 having passed into the classified service.

Secretary Wilson reviews at length the production and exports of American agricultural products. The increase in the exports of farm products for the half century ended 1901 was from $147,000,000 to $952,000,000—550 per cent. The exports of farm products for the closing decade of the last century were over $700,000,000 a year, and for 1903 over $878,000,000, an amount second only to that of 1901.

Although the consumption of cotton in this country is greater than that of any other country in the world, yet, in addition to supplying the home market, the South exported last year over 3,500,000,000 pounds of cotton, worth $317,000,000.

Of grain and grain products, the export exceeded in value $221,000,000, and in the supply of animals, meats, and meat products the value of exportation was $211,000,000.

Discussing the balance of trade, the Secretary shows that the favorable balance to the credit of this country is due entirely to the farmers. The balance of trade in favor of farm products during the last fourteen years, no year excepted, aggregated $4,806,000,000. In products other than those of the farm, during the same period the balance of trade was adverse to this country to the extent of $865,000,000. Our farmers not only canceled this immense obligation, but placed $3,940,000,000 to the credit of the nation when the books of international exchange were balanced. He concludes that "it is the farmers who have paid the foreign bondholders."

Reviewing the magnitude of agricultural production, after giving the figures of the most important crops, Mr. Wilson says that the value of all farm products, not fed to live stock, for 1903 considerably exceeded their value in the census year, when it was given at $3,742,000,000.

According to the department's inventory of farm animals for January 1, 1903, the value of horses was over $1,000,000,000, and of mules nearly $200,000,000. The value of cattle of all kinds considerably exceeded $1,300,000,000, of sheep $168,000,000, and of hogs, $365,000,000.

The Secretary reports a gratifying extension in public education along meteorological lines. Regular courses of lectures or classes have been conducted by Weather Bureau officials in not less than twelve colleges and universities. Many of the representatives of this bureau have, moreover, delivered occasional addresses in other classes or colleges, and to teachers of schools. The demand for instruction on these subjects increases rapidly.

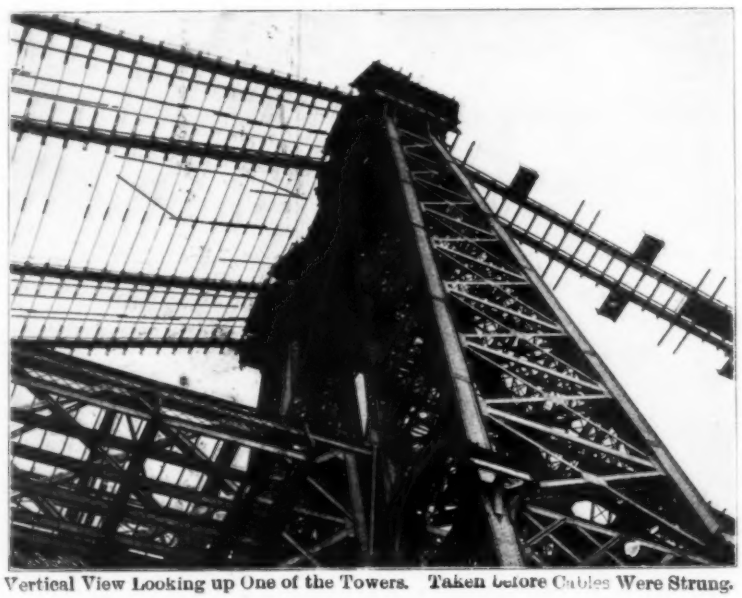
A distinct advance by the Weather Bureau is noted in the preparation of daily weather charts at three different levels, i. e., the sea level and at the 3,500-foot and 10,000-foot planes. So far, this improvement is confined to the barometric pressure, but it is most important to secure charts of the temperature on the two upper planes as well, and unfortunately these can be secured only by means of balloon and kite ascension.

It is proposed to establish at Mount Weather, Bluemont, Va., a modern meteorological observatory of the best class. A building for administration and a school of instruction are now being constructed, and there will be a suitable power house and shop for balloon and kite ascensions. The Weather Bureau is preparing to study, at first hand, variations in solar activity and corresponding changes in weather conditions from season to season. This will require the best instrumental equipment, students, and a long series of observations. The importance of the results will justify all efforts to that end.

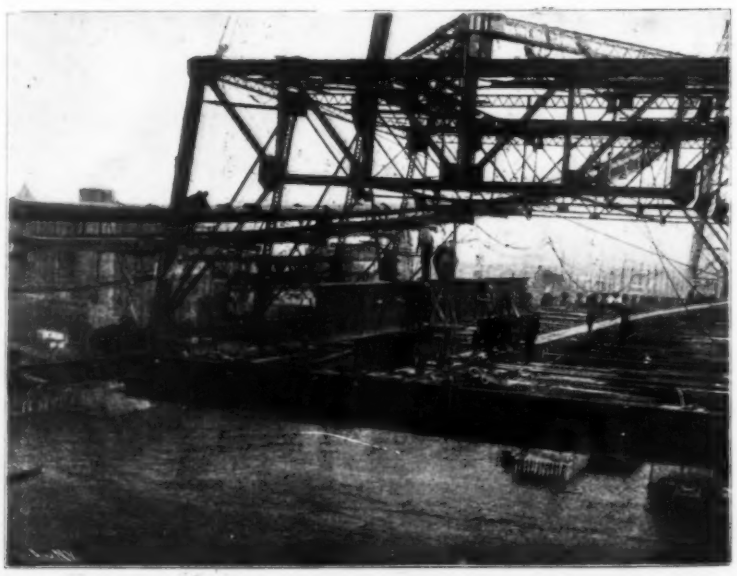
During the past season extensive field tests have demonstrated the value of the nitrogen-fixing bacteria in leguminous crops—good stands of clover, alfalfa, and other crops have been secured on soils where, without these bacteria, these crops were a failure. As a result of these experiments the department is prepared to furnish a reasonable quantity of organisms for the principal leguminous crops and patents have been applied for covering the

INSHORE END OF THE STIFFENING TRUSSES.

View Looking Along Axis of Bridge, Showing the Floor between Cables Erected. Cantilever Extensions of the Floorbeams, Extending 20 Feet beyond the Cables, will be Bolted on, Making a Total Width of Floor of 120 Feet.



Vertical View Looking up One of the Towers. Taken before Cables Were Strung.



The Traveler and Derrick, with Which the Erection Was Done. Preparing to Lift a 10-Ton Floorbeam into Position.

BUILDING THE FLOOR OF THE NEW EAST RIVER BRIDGE.

process used in order to make them securely available for the public.

Satisfactory results are recorded with the hybrid or long-staple upland cottons, and extensive field tests are now under way, and if the result of the present season's work is satisfactory seed will be grown for distribution. Indications at the present stage of experiments also favor the belief that we shall soon have varieties of Egyptian cotton adapted to cultivation in this country. At present we pay Egyptian growers $7,500,000 annually for their cottons.

The wilt-resistant Sea Island varieties of cotton distributed by the department last year and this year have proved very satisfactory. Progress has also been made in securing varieties resistant to Texas root rot and other pests.

The secretary reviews at considerable length the work of the Bureau of Plant Industry in combating plant diseases of all kinds, especially of orchard fruits, truck crops and the California vine disease. The department now feels certain that bacterial blight of pears and apples can be controlled. In the case of wilt disease the only way to control this is by the use of resistant varieties. The Lenoir vine has been found resistant to the California vine disease, and this vine has been used successfully both as a top graft and as a root upon which to graft other varieties. Excellent results have followed the co-operative work of the Bureau of Plant Industry and the Bureau of Forestry in the study of methods of timber preservation and seasoning.

Considerable work has been done at the Arlington Farm. Over 400 varieties of apples and 150 sorts of peaches are now growing in the farm nursery. This nursery also contains several thousand seedling oaks, ashes, and maples grown from seeds gathered from trees in the District of Columbia. A fruit plantation of 1,000 trees has been established on the farm as a basis for studying the physiological action of various insecticides and fungicides. A small typical cranberry plantation has also been undertaken, while an area of some thirty acres is being prepared as an aboretum. Among other experiments being conducted on the Potomac flats testing garden are the effects of shade on growing crops. As rapidly as the facilities of the department will permit all truck plants grown for leaf production will be submitted to the influence of shade.

Secretary Wilson reports a satisfactory development of the beet sugar industry. In 1896, 29,220 tons of sugar were made, and a year ago, 220,000 tons. Careful estimates put the present crop at about 260,000 tons. The growing of seed in the United States of a superior quality is assured. He concludes that the industry is now well established.

In reviewing the accounts and disbursements of the department he reports the total appropriations for the fiscal year ended June 30, 1903, as $5,013,960. The sum actually expended leaves a balance of over $700,000, most of which, however, is covered by outstanding liabilities. On June 30, 1903, all accounts for the fiscal year 1901 having been settled, an unexpended balance for that year of $65,127.50 was covered into the treasury. The amount paid for rent of buildings in the District for the use of the department for the year 1903 was $21,700; the expenditure for the same purpose for the current year is $27,900.

In regard to new buildings, the secretary reports that plans have been prepared so as to provide for a series of buildings connected with pavilions in such a way as to make practically one harmonious structure. The chief advantage of this plan is that it will permit of adding indefinitely to it as the needs of the department grow. The scheme as a whole provides for the erection of ten buildings, only three of which, however, can be erected for the amount authorized by Congress. These will have a floor space of 100,000 square feet, which will suffice to bring within these structures all branches of the department now paying rent.

The invasion of the cotton boll weevil has been a special menace to cotton and has awakened widespread apprehension as to the future of this crop. In addition to the excellent work of the Division of Entomology in combating this pest, the Bureau of Plant Industry has during the past year done considerable work with a view to securing, if possible, early and resistant varieties by breeding and selection. Notwithstanding all that has been accomplished, however, the boll weevil is constantly spreading north and east, and it seems but a question of time when it will reach all the cotton-growing States. The country is thus confronted with a very great problem, as the invasion of this insect necessarily means a complete revolution in present methods. The secretary reports that after a personal visit to the South and a thorough canvass of the situation with representative men in Congress and with others, he is of the opinion that a cotton investigation fund should be appropriated for immediate use in connection with this problem. He believes that not less than $500,000 should be appropriated and made immediately available to make this work comprehensive and thoroughly effective, and he enumerates in detail ten problems to the solution of which these funds should be devoted.

MAKING THE FINAL CONNECTIONS AT THE CENTER OF THE 1,600-FOOT SPAN.

The member shown suspended from the cables is a 60-foot section of the bottom chord of the stiffening truss.

PRODUCING HIGH TENSIONS BY MEANS OF ALTERNATING CURRENT.

THE problem of obtaining very high tensions has assumed of late years an ever-increasing importance for the investigation of many phenomena, as well as for practical purposes. High-tension direct current cannot be generated by means of dynamos or high-tension batteries, except at a very high cost. 40,000 volts being about the maximum tension obtained in this connection. Although by means of influence machines tensions as high as 100,000 volts and more are obtained, the current intensities thus produced are low, and the possibility of a further increase of the tension seems to be out of the question. Modern induction coils now afford a means of producing tensions corresponding with sparks one meter and more in length. Accurate measurements, however, have not so far been carried out with these tensions. This, as pointed out by Mr. W. Wien (Physikalische Zeitschrift), is due in the first place to the fact that present interrupters all work irregularly, and that the differential quotient of the current with regard to time, as determining the tension obtained, can not be calculated. To this uncertainty, the author thinks, our insufficient knowledge as to the processes occurring in large induction coils is due. The only practicable means of measuring the high tensions obtained by induction coils is in Mr. Wien's opinion the use of alternating instead of direct current. In the case of sinusoidal currents, the processes occurring in the circuit are liable to be theoretically controlled and checked by accurate measurements. The currents generated by our alternating-current machine, though not strictly of the above type, show no material departures from it, in addition to being susceptible of analysis.

When operating a large induction coil by alternating current, with 100 alternations, the tension obtained is generally placed between 30,000 and 50,000 volts, a current of 5 to 7 amperes being sufficient in the case of a primary tension of about 50 volts. As the ratio of the secondary tension to the primary tension is approximately proportional to the ratio of the numbers of windings of the secondary and primary coils, a ten-fold tension may be obtained either by increasing the number of windings of the secondary coil to a ten-fold value, or by decreasing the number of windings of the primary coils to the tenth part with the same number of alternations. In the case of the first method, a rather cumbersome and exceedingly expensive secondary coil would be required; whereas in the second case, the apparent resistance would have to be decreased to the 100th part, and the intensity of the current accordingly increased to a one-hundred-fold value.

When increasing, however, the number of alternations

VIEW OF THE COMPLETED EAST RIVER BRIDGE, LOOKING TOWARD MANHATTAN.

of the current to a ten-fold value, the apparent resistance again increases to a value ten times greater, so that if the number of windings of the primary coils be decreased to the tenth part, only a ten-fold current, but at the same time an increase in the secondary tension up to a ten-fold value, is obtained. This method affords the advantage of preserving the secondary coils

FIG. 1.—THE COLLAPSED AIRSHIP, SHOWING THE EXPLODED GAS-VESSEL AND THE TAIL.

of present induction coils in their actual form. According to these principles, Messrs. Schuckert & Co., Nuremberg, built an alternating-current machine for 1,200 alternations per second, giving at a tension of about 100 volts an output of 4 kilowatts. The motor is an 8-horsepower shunt motor requiring about 7 kilowatts at a tension of 220 volts, the normal number of revolutions being 2,000 per minute. As the machine has 36 poles, the number of alternations required is obtained. The alternating current as supplied by this machine would immediately, without any additional resistance, be led into the primary coil of an Ernecke induction coil having a spark as long as 40 centimeters, when the anticipated high tension was developed without any difficulty. A particularly strong stream of sparks would jump through an air gap 38 centimeters in length between two spheres, the intensity of the primary current being 42 amperes at 40 volts. The excitation of the machine necessary to this effect was comparatively low, corresponding with a no-load tension of 65 volts. In the case of a stronger excitation of the magnets, the sparking would be converted into a brush discharge; this method would therefore have been susceptible of readily giving much higher tension.

These experiments go to show that with existing large induction coils, the tension, as obtained by means of interrupters, may also be obtained by means of alternating-current machines of 1,200 alternations, provided a suitable primary coil be chosen, thus affording a means of subjecting these high tensions to accurate measurements.

LEBAUDY AIRSHIP DISASTER.

EVERYONE interested in the progress of aerial navigation will have read with something of a sense of personal loss of the disaster which occurred to the Lebaudy airship on November 21, just as it was arriving at the headquarters of military ballooning at Chalais-Meudon. After its triumphant voyage to Paris from Moisson, which we chronicled in our last issue, the airship had been lying in state, an object of the greatest interest to all classes in Paris, in the Galerie des Machines on the Champ de Mars. On Friday, the weather being in the morning apparently favorable and the overhauling of the airship having been completed, it was decided to continue the journey and pay a visit to Col. Renard, the pioneer of the navigable airship movement, at the aeronautical headquarters at Meudon. The wind, though not very powerful at the start, was fitful and contrary, but in spite of this the airship, after having been brought out from the building and the engine started, rose majestically from the ground, and sailed away more or less against a stiffish wind in the direction of St. Cloud, crossing the Seine, and heading for the wooded valley in which Chalais-Meudon is situated. The indomitable M. Juchmès had considerable difficulty in keeping the airship up to the wind, and on passing the Orphanage of Galliera his difficulties were quite exciting to watch. From observations reported from the Eiffel Tower, it was known that the wind was blowing still stronger higher up, so the aeronaut descended as near the ground as possible, some of the trail-ropes actually grazing the roof of the Orphanage as it was passed. Everything went well, however, till just as the airship was about to descend on the tree-studded lawn at Chalais-Meudon. M. Juchmès had already stopped his motor, and Col. Renard with a number of visitors, including MM. Paul Lebaudy and Julliot and Mesdames Juchmès and Ray, came forward to meet it. A number of the soldiers of the balloon department rushed forward to grasp the trail ropes of the airship, but M. Renard, anxious to see the vessel descend to the ground, unfortunately restrained them. At this moment, when the car was some 18 feet from the ground, a sudden squall of wind caught the airship and drove it against a lofty tree. The envelope of the gas-vessel, being subjected to considerable pressure, as our readers are aware, to maintain it taut and rigid, was caught and ripped by the branches, and exploded at once, the gas with which it was inflated escaping instantaneously, and down came the car with the ruined envelope on top of it, as seen in our Fig. 1. Fortunately both aeronauts were uninjured, and were extricated from the *débris* without much difficulty. It is hardly possible to say at present how far the airship can be repaired. The conical ends of the gas-vessel, at any rate, are uninjured, and the car is practically undamaged, but the propeller-shaft is seriously injured, and the aeroplanes forming the tail badly twisted—not so badly, however, it is thought, but that they can be put right. In any case we fear that the records of the Lebaudy for this year are over. Everyone will congratulate the two intrepid aeronauts on their providential escape, and sympathize with them and M. Lebaudy on the misfortune. It was an accident pure and simple, and does not really redound in any way to the discredit of the designers and navigators of the hitherto brilliantly successful machine, but it does show that airships of this class must be very careful in selecting their ground when alighting. In this respect they differ from the ordinary spherical balloon in which the tension of the gas envelope is nothing like so great as in an airship, which has to be kept rigid by means of an internal ballonette in order to prevent distortion. It is probable, we understand, that in any case a Lebaudy No. 2 will be built, and there is reason to suppose that either the propellers will be increased in size, and their pitch slightly altered, or a single large propeller substituted for the two that have already been employed. When we consider the thirty-two not merely successful but record journeys which this first airship constructed by M. Julliot has made, we can only hope that he will at an early date have an opportunity of showing to what extent he has profited by the brilliant experience furnished by Lebaudy No. 1 and design a vessel which shall even surpass the records which that craft has made. After all, the accident is only in aerial navigation similar to what must have happened a thousand times to sailing vessels before harbors were constructed, and would happen frequently now, even with steam vessels, if harbors did not exist.—The Automotor Journal.

FIG. 2.—THE WRECK SEEN FROM THE OTHER SIDE.

Showing the overturned "hull" with the muffler, gasoline tank, part of the motor, one of the propellers, and the horizontal aeroplane above.

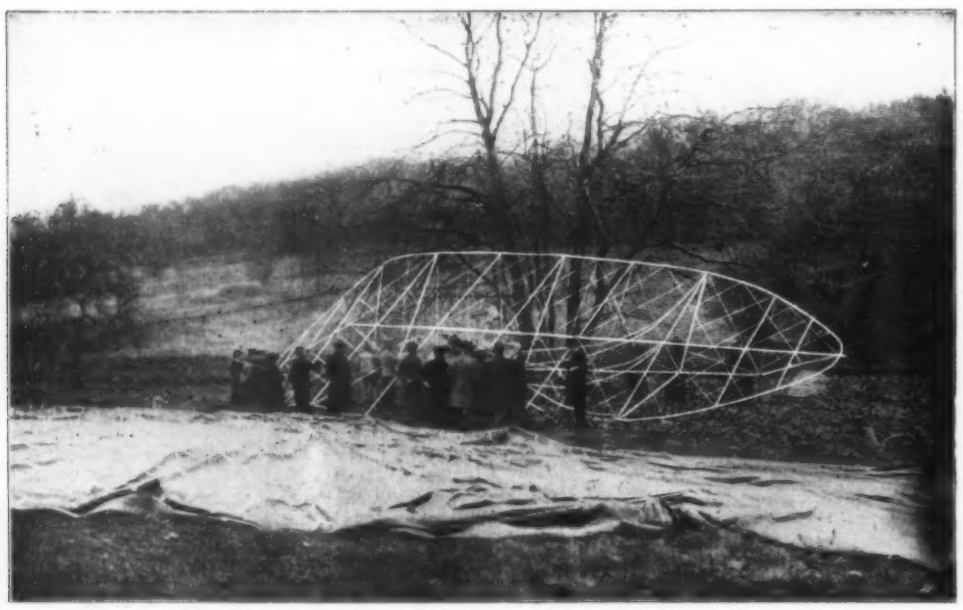


FIG. 3.—THE FRAMEWORK AND ENVELOPE AFTER THE ACCIDENT.

NEW BULLETS.

MUCH has been said and written for and against using cast or leaden alloy bullets in the modern quick twist rifles. The manufacturers of ammunition generally instruct their patrons that they cannot be used. Of course, anyone knows that if he is required to purchase a new cartridge every time he shoots, his sport must soon become very expensive. Many who desire to economize and at the same time convert their high-power rifles into less dangerous weapons for short-range armory work and small-game shooting at distances of 200 yards and under, will be interested in the bullets designed by Mr. Barlow, of the Ideal Manufacturing Company. They have proved to be wonderfully accurate. With bullet No. 308241 Lieut. W. C. Gannon, of Company C, 4th Regiment of Infantry, New Jersey National Guard, made ten consecutive bull's eyes at 200 yards, Creedmoor target, at the regimental range at Marion, N. J., on October 3, 1903. This shooting was done standing, offhand, with regular military sights. Again, on October 10, 1903, at the regimental armory indoor range, 80 yards, he, in a standing position, offhand, made five successive bull's eyes. Afterward, in the prone position, he made nineteen successive bull's eyes, the other shot being a four, scoring ninety-nine out of a possible one hundred, which is believed to be the highest indoor score ever made with a military rifle (30-40 Krag-Jorgensen). There was no cleaning and no leading.

The information relative to this wonderful shooting Lieut. Gannon gives as follows: For the 200-yard range, sights were elevated for 600 yards. For the 80 yards the elevation was 415 yards. Shells used were U. M. C.; primers, U. M. C. No. 8½. For the 200 yards the charge was 9 grains of Laflin & Rand's "Sharpshooter" powder, and for the 80 yards 8 grains of the same powder. The bullet was cast from Hudson's alloy, sized in Ideal lubricator and sizer, left .312

inch in diameter. It was seated in shell with Ideal No. 3 tool, forward band projecting beyond the muzzle of the shell, shell not crimped, but indented with Ideal shell indenter. This combination of bullet, powder, shells, primers, firearm and "man behind the gun" sems to demonstrate without a doubt that shells may be reloaded advantageously with lead bullets and smokeless powders for use in modern quick-twist rifles.

We are informed by the Ideal Company that bullets Nos. 308241 and 311243 will hereafter be cut in the molds attached to No. 6 tool for all of the 30-30s and 303 Savage rifles, respectively, and that these bullets may be seated with the same chamber that seats the regular metal-patched bullets for those arms. In that case, the chamber will crimp the same as it does with the metal-patched bullet, but there must be extra chambers with no crimp for seating the bullet, same as Lieut. Gannon's.

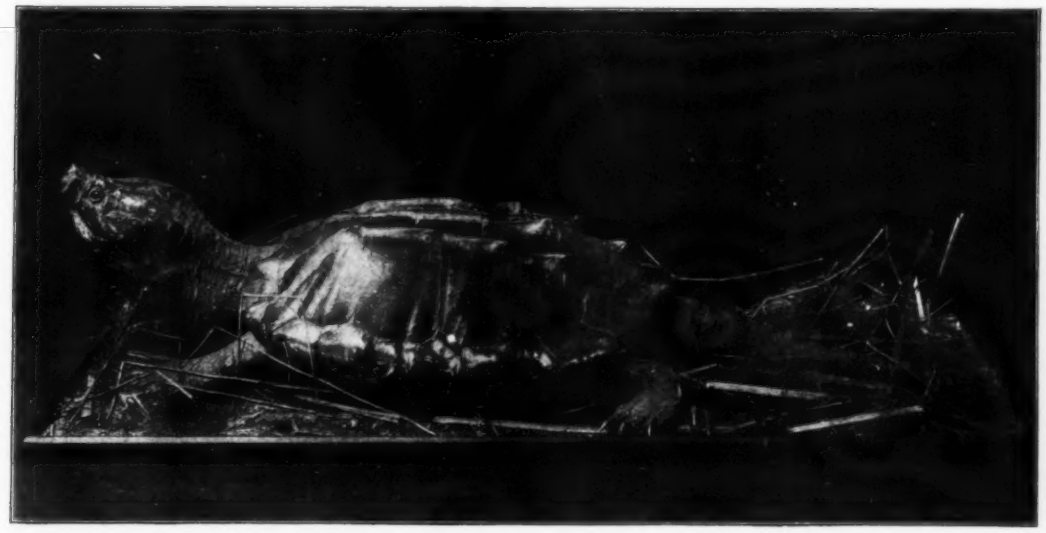
NEW ELECTRIC TRACTION EXPERIMENTS ON PRUSSIAN RAILWAYS.

IN the experiments which have just been commenced on the Spindlersfelder line in the environs of Berlin, it is not intended to attain high speeds, but rather to demonstrate the practicability of the single-phase alternating current as supplied to the new motor designed by the Union Elektricitäts-Gesellschaft. The Union Elektricitäts-Gesellschaft and the Allgemeine Elektricitäts-Gesellschaft, as is known, have recently combined, forming the largest European concern in the field of electric industry. That there is no difficulty whatever in the operation of interurban or suburban lines by electricity has been proved sufficiently in England and America, as well as lately on the Lichterfelde line of the Prussian Railway. But when a line of 100 to 300 miles' length is to be operated by electricity, the present methods, though successful in short lines, become too expensive. The comparatively low-pressure continuous current must be generated in a number of sub-stations distributed along the line, these sub-stations being fed from one or more central stations acting as boosters. Such sub-stations for the production of continuous current from alternating current require rotary converters and entail a large first cost and expensive maintenance and care. Such sub-station containing machinery may be replaced by sub-stations which are very low in first cost and maintenance, provided alternating current is used on the trains. A number of different methods have been suggested for accomplishing this, and one or two roads of more or less promise are being built in different countries. The simplicity of the motor in question, however, seems to put it far ahead of anything else produced up to date, and it seems to have all the best characteristics of the ordinary tramway motor which has proved so successful all over the world. The great point, however, is that it is capable of every desirable degree of speed regulation without requiring expensive, cumbersome, and uneconomical regulating devices. In the present case only one wire is used to transmit the current to the car, and the pressure of 6,000 volts is so high that this wire may be very small. The working current is led directly to the motors without any previous transformation. This system is so simple that it may easily be applied to lines connecting cities 200 or 300 miles apart.—A. G.

THE ALLIGATOR SNAPPER.

A CAST of one of the largest and most interesting specimens of the turtle is to be found in the U. S. National Museum at Washington, which specimen is popularly known as the alligator snapper.

This turtle is found in the southwestern United States. It is the largest species of fresh-water turtle now existing, and is only surpassed in the class Testudinata by the giant tortoises of the Galapagos Islands. The specimen exhibited is the largest one of the species of which there is any record, and hence the largest American fresh-water turtle thus far known. The shell



ALLIGATOR SNAPPER.

is 29½ inches long and 34 inches wide. It was obtained in southern Texas. Other interesting American turtles exhibited were the snapping turtle, the curious soft-shelled turtle, the box tortoise, etc. A very good specimen of one of the large Galapagos Islands land tortoises was also exhibited. Specimens of the matamata of Brazil, the most grotesque turtle known, and the large Amazon River turtle were also prepared, but could not be exhibited for lack of space.

Our illustration comes from the Report of the U. S. National Museum.

A FAMILY GROUP OF SIOUX INDIANS.

THE accompanying illustration, taken from the United States National Museum's report, illustrates a Sioux family, which may well be taken as a type of the Great Plains ethnic province.

It is on these plains that the Sioux, Algonkin, and Kiowa developed their peculiar culture. The activities of all these tribes were created and fostered by the buffalo—including their food, dress, tents, tools, utensils, arts, industries, social life, lore, and religion. In the group appear the man, who is the hunter, returning with a trophy of the chase; the wife, who is butcher, tanner, clothier, purveyor, pack animal, and general drudge, is dressing a hide; the young girl is beading a moccasin for her sister, who is interested in the work. The smaller boy, with bow and arrow, welcomes the father. The tribes of the Great Plains are thought to have been in early times sedentary, but the acquisition of the horse and the gun fostered a more roving life.

FAMILY GROUP OF SIOUX INDIANS.

CONTEMPORARY ELECTRICAL SCIENCE.*

CHARGE OF GASEOUS IONS.—The method devised in 1898 by J. J. Thomson for measuring the charge carried by an ion in a conducting gas, and carried out by Wilson by means of the condensation-cloud device, assumes that the sudden expansion of the air leads to the condensation of water vapor, which takes place on all the ions, both positive and negative. Subsequent experiments have, however, shown that when the ratio of expansion does not exceed 1.31 only the negative ions are caught. Now the number of ions present is measured by determining the current carried by ions moving with a known velocity. This gives ne, the product of the number of ions by the ionic charge. Owing to the error mentioned, n comes out about half its real value, and therefore e, the charge, comes to twice its real value. J. J. Thomson has, therefore, carried out experiments at various expansion ratios. He found that when the ratio exceeds 4 : 3 all the ions are brought down by the condensing vapor, and a further expansion does not add to the number precipitated. Below that figure, and down to a ratio of 5 : 4, negative ions are precipitated, and when the ratio of expansion falls still further only a portion of the negative ions are brought down. The charge of gaseous ions must therefore be put at 3.4×10^{-10} electrostatic units. The number of molecules in 1 cubic cm. of gas under standard conditions results as 3.6×10^{19}.—J. J. Thomson, Phil. Mag., March, 1903.

LOADED LINES IN TELEPHONIC TRANSMISSION.—G. A. Campbell gives a mathematical investigation of the effect of inserting self-induction coils on long telephone lines, and adds an account of some experiments which show that there is a distinctly favorable effect as soon as the length exceeds 15 miles. He worked with a cable circuit 46 miles in length, partly artificial, containing 100 equally-spaced T-14 loading coils. The initial loss due to the loading was found to be equivalent to the introduction of 9 miles of standard cable, but on account of the greatly reduced attenuation, the loaded line is better than the unloaded line for all distances greater than 15 miles. In the author's arrangement, the distance over which transmission of a given volume could be obtained was nearly trebled by the loading, and the quality was improved in addition. At the transmitting end a person talked in a steady, monotonous manner, and at the receiving end a person could switch instantly from the loaded line to the artificial cable standard, and *vice versa*, and alter the length of the cable standard to secure an equal volume of transmission over the two. The comparison gave the equivalents of the two circuits for commercial service. The author admits that a great deal of further experimental work remains to be done.—G. A. Campbell, Phil. Mag., March, 1903.

ARTIFICIAL ELECTRIFICATION OF THE EARTH.—Marconi's successful transmission of signals through an arc of 50 deg. has led E. Lecher to elaborate his theory of wireless telegraphy, according to which electric waves are transmitted along the earth's crust as waves are along wires. Signals could be transmitted in this manner over the whole earth if it were possible to raise the potential of the earth a few volts. This could only be effectively done if the negative electrification could be removed to a point outside the earth, say to the moon. Otherwise it would not be impossible to construct condensers of capacities not very small in comparison with the earth's capacity. Now, what the antenna or mast wire does in wireless telegraphy is some such action as that postulated. It conducts the opposite electrification away from the earth for some distance, say 150 feet, and conducts it back at the next reversal. Its foot, therefore, gets charged positively and negatively in alternation, and these charges are transmitted at a rate depending upon the dielectric constant and magnetic permeability of the earth. The author suggests the following experiment: Let a wire be earthed at two points in a direct line from the antenna, and let its length be half the wave-length of the oscillations. Its ends will then be always oppositely charged, and the maximum alternating current will pass through it. If placed at right angles to the waves, it will show no response.—E. Lecher, Physikal. Zeitschr., March 1, 1903.

UNDEFLECTED RADIUM RAYS.—H. Becquerel has succeeded in completely establishing the identity of polonium rays, "undeflected" radium rays and canal rays. He operated with preparations mounted in a narrow gutter in a block of lead, and took photographic impressions of the rays deflected first in one direction and then in the other. He thus obtained two parallel lines from each preparation. The lines were theoretically elliptical, but practically straight. As he pointed out before, these rays are only non-deviable by comparison with the radium rays, which consist of negative electrons and constitute Rutherford's β-radiation. The lines obtained were very sharp, and their distance apart could be measured with the micrometer. The distances were the same in both cases, and the lines could be superimposed. Moreover, the deflection was always in a sense opposed to the deflection of the negatively charged β-rays. There was no trace of dispersion, such as happens in the latter. Uranium rays consist of negative electrons, polonium rays of positive ions, and radium and thorium rays of both. Radium also emits a third kind of radiation, which is non-deviable and yet very penetrating. It presents most of the characteristics of Röntgen rays, and traverses a quartz prism of 60 deg. without deflection.—H. Becquerel, Comptes Rendus, February 16, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

TRADE NOTES AND RECIPES.

Preservative Composition.—A new German composition, or paint, for protecting stone, wood, cement, etc., from the effects of damp or other deleterious influences consists of quicklime, chalk, mineral colors, turpentine, boiled oil, gallipot, rosin, and benzine. The lime, chalk, colors, and turpentine are first mixed and then made into a paste with the boiled oil. The paste is finely ground and mixed with the rosins previously dissolved in the benzine.

Antifrost Solution.—As an excellent remedy against the freezing of shop windows, the Pharmaceutische Zeitung recommends the application of a mixture consisting of 55 grammes of glycerine dissolved in 1 liter of 62 per cent alcohol, containing, to improve the odor, some oil of amber. As soon as the mixture clarifies, it is rubbed over the inner surface of the glass. This treatment, it is claimed, not only prevents the formation of frost, but also stops sweating.

Removing Oil Stains from Marble.—Saturate fuller's earth with a solution of equal parts of soap liniment, ammonia, and water, apply to the greasy part of the marble, keep there for some hours pressed down with a smoothing iron sufficiently hot to warm the mass, and as it evaporates occasionally renew the solution. When wiped off dry the stain will have nearly disappeared. Some days later when more oil works toward the surface repeat the operation. A few such treatments should soon get it entirely out.—Drug. Circ.

Producing Colors by Mixing Pigments.—According to S. Paris Davis colors may be produced by mixtures of pigments as follows:

Bismarck brown.—Take carmine, crimson lake and gold bronze, and mix together. If a light shade is desired, use vermilion in place of carmine.

Bottle green.—Dutch pink and Prussian blue for ground; glaze with yellow lake.

Brick color.—Two parts of yellow ocher, one of red and one of white.

Bronze green.—Five parts of chrome green, one of black and one of umber.

Brown.—Three parts of red, two of black and one of yellow.

Canary yellow.—Five parts of white and three parts of lemon yellow.

Carnation red.—Three parts of lake and one of white.

Chestnut color.—Two parts of red, one of black and two of chrome yellow.

Chocolate color.—Add lake or carmine to burnt umber or take Indian red and black to form a brown; then add yellow to bring about the desired shade.

Citron.—Three parts of red, two of yellow and one of blue.

Claret.—Red and black, or carmine and blue.

Clay drab.—Raw sienna, raw umber and white lead, equal parts; then shade with chrome green.

Copper color.—One part of red, two of yellow and one of black.

Cream color.—Five parts of white, two of yellow and one of red.

Deep buff.—The same, with the addition of a little red.

Drab color.—Nine parts of white and one of umber.

Dove color.—Red, white, blue and yellow.

Fawn color.—Eight parts of white, one of red, two of yellow and one of umber.

Flesh color.—Eight parts of white, three of red and three of chrome yellow.

French gray.—White shaded with ivory black.

French red.—This color is simply Indian red, lightened with vermilion and glazed with carmine.

Gold color.—White and yellow, shaded with red and blue.

Grass green.—Three parts of yellow and one of Prussian blue.

Green.—Blue and yellow or black and yellow.

Jonquil yellow.—Mix flake white and chrome yellow and add vermilion or carmine.

Lead color.—Eight parts of white, one of blue, and one of black.

Lemon color.—Five parts of lemon yellow and two of white.

Light buff.—Yellow ocher, tinted with white.

Light gray.—Nine parts of white, one of blue and one of black.

Lilac.—Four parts of red, three of white and one of blue.

Maroon color.—Three parts of carmine and two of yellow.

Medium gray.—Eight parts of white to two of black.

Oak color.—Five parts of white, two of yellow and one of red.

Olive brown.—One part of lemon yellow with three parts of burnt umber. Change the proportions for different shades.

Olive color.—Eight parts of yellow, one of blue and one of black.

Peach blossom.—Eight parts of white, one of red, one of blue and one of yellow.

Pea green.—Five parts of white and one of chrome green.

Pearl color.—White, black and red in proportion to suit the taste.

Plum color.—Two parts of white, one of blue and one of red.

Portland stone.—Three parts of raw umber, three of yellow ocher and one of white.

Purple.—The same as lilac, but differently proportioned; say two parts of blue.

Rose color.—Five parts of white and two of carmine.

Salmon color.—Five parts of white, one of yellow, one of umber and one of red.

Snuff color.—Four parts of yellow and two of Vandyke brown.

Stone color.—Five parts of white, two of yellow and one of burnt umber.

Straw color.—Five parts of yellow, two of white and one of red.

Tan color.—Five parts of burnt sienna, two of yellow and one of raw umber.

Violet.—Similar to lilac, but more red than purple.

Willow green.—Five parts of white and two of verdigris.

ELECTRICAL NOTES.

A through schedule of electric trains is to be arranged between Erie, Pa., and Cleveland, Ohio, a distance of about 100 miles. Two important links in the chain of railroads extending between the two cities have recently been completed and placed in operation. A meeting of the half dozen companies interested in the plan will soon be held for the purpose of determining upon the final details.

The De Forest wireless telegraphy system was successfully tested recently by the British postal authorities between Howth and Holyhead, a distance of 64 miles. Messages were transmitted at the rate of thirty and thirty-five words a minute, the replies being received quicker than by the ordinary telegraph. Although a Marconi station was close to the De Forest installation at Holyhead, there was no noticeable interference with the messages.

Central station driven by wind power is described in the Zeitschrift für Elektrotechnik, which republishes a lecture given by Mr. P. La Cour before the technical congress at Copenhagen, and relating to prolonged tests—undertaken at the request of the Danish government—regarding the possibilities of wind motors for driving electric generators. The device adopted by the lecturer for obtaining a driving speed independent of the wind-pressure is as follows: A vertical belt runs from the pulley of the wind motor to a pulley on a countershaft, this being supported by a balance. As soon as the output of the dynamo exceeds a certain limit, the vertical belt begins to slip, and by this means it is possible to keep the generator speed within predetermined limits. As an additional precaution an overload cutout is provided, and a minimum cutout opens the circuit whenever the wind-pressure falls below a certain limit. A small power station built on these principles has been continuously running at Askov since October, 1902, and furnishes current for 450 lamps. As a reserve a small petrol engine has been installed. The initial cost of the plant is given as £800.

When the first power house at Niagara Falls was proposed for a capacity of 50,000 horse power, with an ultimate tunnel capacity of 100,000 horse power, many people wondered how it would be possible to dispose commercially of such a large amount of electric power. Central station managers who, after a strenuous canvass for new customers, had been accustomed to increasing the output of their plants by the addition of a 150-kilowatt Edison bipolar, were staggered by the magnitude of the quantities involved in this new proposition. Since that time, however, great developments have taken place in the electrical arts which have made possible the present realization of such a large demand for electrical power. As a result of these, the first power house has reached the limit of its capacity of 50,000 horse power; the second plant, having a capacity of 55,000 horse power, is well along toward its limit, and a third power house of 110,000 horse power is being constructed on the Canadian side of the river to operate in conjunction with the first two, thus making a total of 215,000 horse power. The second plant on the American side, known as Power House No. 2, is constructed near the first power house, but on the opposite side of the inlet canal. Its equipment consists of eleven 5,000 horse power vertical shaft, 2,200-volt, 25-cycle, two-phase generators of the same speed as those in the first plant, viz., 250 revolutions per minute. The first six machines of the installation are of the external revolving field or umbrella type; the last five generators have internal revolving fields with outside stationary armatures, the speed remaining the same. This internal revolving field construction affords many advantages of simplicity and accessibility to the various parts of the machine. The general construction of Power House No. 2 is the same as that of the older plant, with which almost everyone is familiar. The changes introduced have been principally along the line of improvements in detail which have been the result of the evolution which has taken place in engineering methods since the first plant was installed. As already stated, a third power house is being constructed on the Canadian side of the river, which will serve to supply the demand for power in both Canada and the United States when all the power from the two American plants is taken up. The work is being carried on by the Canadian Niagara Power Company, a Canadian corporation controlled by the Niagara Falls Power Company. The capacity of this plant, when completed, will be 110,000 horse power. In general, its hydraulic development will be similar to that of the American plants. The power house is situated in the Queen Victoria Niagara Falls Park, about one-half mile above the Horseshoe Falls. The most distinctive feature of this plant is the size of the generating units, each of which is to have a capacity of 10,000 horse power, the largest machines which have thus far been constructed. The plant, when completed, will comprise eleven of these generators. A unit of this size was adopted for reasons of economy in hydraulic development and in electrical equipment. These 10,000 horse power units occupy but little more space than those of 5,000 horse power. Thus results a great reduction in length of wheelpit and power house for a given horse power output. Furthermore, the generators cost considerably less per horse power than those of 5,000 horse power capacity. They are wound for three-phase, 11,000 volts, 25 cycles at 250 revolutions per minute. This high generated voltage was selected not for long-distance transmission, but for economy in local distribution of power. The first installation in the Canadian plant will consist of five such 10,000 horse power generators. It is the intention to have cable connections so that this Canadian power house can operate, if desired, in parallel with either or both of the American plants. This plant will be in operation by July 1, 1904. Its output will be used for Canadian industries in the province of Ontario within transmission distance of the power house, or for American consumers, as the demand may be. A part of its output may be sent to Buffalo by a transmission line to be built on the Canadian side of the Niagara River.—H. W. Buck, in Cassier's Magazine.

ENGINEERING NOTES.

Probably few have thought of the Blake rock-breaker as one of the great inventions, says the Engineering and Mining Journal, and yet for the ten years prior to 1872 it has been computed that the direct saving of labor cost by 509 machines then in use was above $[illegible]-000,000, and in the years since then the work of the stone breaker has enormously increased.

A decapod locomotive for the heavy suburban traffic between King's Cross and High Barnet is being tried by the Great Northern Railway, and has been designed by Mr. H. Ivatt. Its length over all is 38½ feet and it weighs 71 tons, of which 58 tons are available for adhesion, while it can bring into play a tractive force exceeding six tons, which is a higher tractive effort than that of any locomotive running. It has been placed in service on the heaviest morning and evening trains between King's Cross, Alexandra Palace, and High Barnet. This line is very steep, including a bank at 1 in 55 from Finsbury Park to Highgate.

A committee appointed by the North of England Institute of Mining and Mechanical Engineers to investigate the question of mechanical coal cutting has just issued the first part of its report, which deals exclusively with long-wall machines. It appears that compressed air machines are still in a large majority, although electricity is being increasingly used as the motive power. Out of a total of 316 machines which were at work in 1900, electricity was the motive power in sixty-nine only, but according to more recent returns the proportion now is about two driven by air to one by electricity. According to the reports of H. M. Inspectors of Mines, the average amount of coal cut per machine per year was about 10,000 tons.

The resistance of fly-wheels has formed the subject for experiment by Herr Scholter, of Nuremberg. The experiments were made on the fly-wheels of two horizontal tandem compound engines developing 450 horse power at a speed of 95 revolutions per minute. The arms of each of the fly-wheels are formed of a double T, with a central web set parallel to the center line of the shaft. It was decided to cover the two faces with a smooth protection of sheet metal. In order to determine the difference in the resistance under the two conditions, with and without the covering, one dynamo was made to serve as a motor to drive the unloaded engine. With the fly-wheel in its original condition the work required was 13,300 watts, while, after the wheel was covered, only 9,874 watts were needed.

A large chimney has just been completed by the Edison Electric Company at South Boston. This chimney, which is of the Custodis construction, is 250 feet 6 inches in height. The external diameter at the base is 24 feet 11¼ inches; internal diameter, 19 feet 6 inches. The external diameter at the top is 17 feet 4 inches; internal diameter 16 feet 8½ inches. The walls of the chimney are 36 inches thick at the base for a height of 3 feet 9 inches, above which they decrease 2 inches in thickness in every 16 feet 5 inches until a height of 200 feet is reached; for the next 25 feet the walls are 10¾ inches in thickness, and for the last 25 feet they are 8¾ inches thick. The astragal starts at a height of 240 feet 6 inches above the ground. The chimney stands on a concrete base 47 feet by 51 feet in area, 14 feet 2 inches deep.

So much prominence has latterly been given to gas engines of large size that the motor of modest output, ranging, say, from 10 horse power downward, has been completely overshadowed; and yet its use has been a steadily widening one, and this, too, in the face of electric motor competition which, at the outset, had by many been considered likely to be a crushing one. Available evidence points to the fact that in many places small steam engine and boiler combinations have been displaced by small gas and oil engines, the gas engines commanding favor even in localities with high-priced gas. In almost every instance the gas or oil engine has been found firmly established either by considerations of convenience, or of superior economy as compared with the small steam motor, or of both. In the marine field, for small pleasure boats, and even comparatively large ones, another outlet has been developed for motors of that type to a degree with which the steam launch engine has failed utterly to keep pace. Gasoline automobile engines are in a class by themselves, perhaps not rightly entitled to consideration here, though they, too, help materially to swell the volume of business in small motors of the internal combustion type.—Cassier's Magazine.

It may not be generally known that Peru possesses great resources for the production of rubber and at present exports a considerable quantity. The best rubber comes from the basin of the Amazon, and in fact Peru is situated for the greater part in that basin. Between the rivers Beni, Madre de Dios, Purus, the Javari, Ucayli, and others are found different varieties of the rubber plant, not only the well-known *Hevea Brasiliensis*, but also other varieties such as the *Castilloa, Sapium*, etc. The production of rubber commenced first on a small scale in 1867, but since 1885 it has become much greater. It is exported almost entirely by way of Iquitos, and very little passes by Mollendo, on account of the difficulties of this route. It was proposed to cut a road 60 miles long in order to afford an outlet to the Pacific coast for the rubber coming from the region between the Inambari and the Beni rivers, but so far the enterprise has not succeeded. Only a very small portion of the rubber forests is worked at present, as the remainder cannot be worked for lack of means of communication, but the forests are already considerably damaged by the natives, who do not take the trouble to bore the trees, but cut them down without regarding the future supply. According to the custom house books the annual exportation from Iquitos is very small for such a productive country and does not exceed 1,300 or 1,400 tons, but these figures cannot be relied upon, as a great quantity is taken out by contraband, and on the other hand it is preferred to export the rubber from Peru by way of the Brazilian ports, as it is given a brand which makes it sell higher. It is estimated that the real production of rubber in Peru reaches at least 40,000 tons annually.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Commercial and Industrial Depression in Germany.—Germany suffered severely during the year ended June 30, 1903, for which this report is written, from a commercial crisis, and a short review of the causes leading thereto will, I hope, be of interest to those engaged or desiring to engage in business in this empire.

CONDITIONS IN 1900.

The tide of commercial prosperity, which had been steadily rising in Germany from 1895 to 1899, began to ebb in the spring of 1900. In the money market the turning point occurred in April, as shown by the drop in the Harpener and Laura shares, criteria for the mining and smelting industries, respectively. These stood:

Shares.	Jan. 2.	April 20.	April 21.	July 2.	Oct. 1.
Harpener	204	244	242.6	185.6	177.5
Laura	255.5	281.4	279.75	217.75	191.5

It will be noticed that of the two the Laura, or smelting industry, was not affected, the percentage of decline in value being approximately double that of the Harpener shares. Symptoms of the ebb showed themselves in a slackness of the textile and building trades. As a consequence of great activity in former years, prices of sites had risen and money was dear, the Imperial Bank's rate of discount ranging between 7 and 5 per cent during the first seven months of the year; hence little building was done and failures had to be chronicled here and there, as in Dresden and Munich, where the builders had continued operations on the same scale as during the flood-tide times. In Berlin, on the contrary, a house famine occurred, and the landlords reaped a rich harvest because of the disproportion between demand and supply. This inactivity naturally influenced the iron market. Beginning with April complaints were loud of a lack of orders for girders. Consumption in the iron, in the metal, and in the machine industries also fell off, and then came the turn of the carriage, cycle, and electric branches. In June Die Metallindustrie Zeitung stated that the demand in Germany had never been so weak as at that time. For a while the iron foundries and coal mines did good business, but toward the close of the year the ebb touched them, and the Rhenish-Westphalian Coal Syndicate announced that from January 1 the output would be decreased by 10 per cent.

Dr. J. Jastrow shows how the depression mirrored itself in the labor market during 1898-1900:

Applicants for every 100 vacant places.

Year.	September.	October.	November.
1898	98.3	114.8	135.9
1899	99.9	109	130.8
1900	100.6	120.4	158.1

October and onward saw workmen discharged in large numbers, mostly in the textile districts. Crefeld, a town of some 100,000 inhabitants, had on October 15, 1900, according to official statistics, 1,300 unemployed weavers and artisans.

CONDITIONS IN 1901.

Things grew worse in 1901 and the crisis was sharpened by the disproportion between the prices of raw material and manufactured products. The raw-stuff syndicates charged as before and refused to recognize the altered conditions. Ever-increasing competition shackled the manufacturers; no new industrial concerns of any importance were founded in the spring, nor did a revival in the building trade take place. Stagnation manifested itself almost everywhere. Wages fell and diminution of output was the order of the day. In the mining branch a reduction of 20 per cent was certified; in the smelting industry, 35 per cent; in the textile industry, from 20 to 40 per cent (cotton-spinning mills); in the paper industry, 10 per cent; and in the wool industry, a minimum output. The number of the unemployed increased to such an extent that the Prussian, Bavarian, Hessian, and Baden governments separately instituted inquiries into the matter. Altogether, at the end of 1901 some 20 per cent of Germany's workmen were without employment. The number of applicants for every 100 vacancies during the first eleven months of 1901 was as follows:

January	165.8
February	146.8
March	122.2
April	141.4
May	145.9
June	148.7
July	160.9
August	150.2
September	147.5
October	198.1
November	223.9

CONDITIONS IN 1902.

At the beginning of 1902 the crisis became still further intensified by a collapse in the coal-mining industry and the consequent discharge of a great many miners. One district alone witnessed the dismissal of 10,000 men in the course of the first few months. The iron trade was kept going by forced sales abroad. The Phœnix Mining and Smelting Company printed in their annual report that they had been doing business with the United States at prices admitting of no profit. Upper Silesian and Rhenish Westphalian iron was sold at a loss. Works in Rhenish Westphalia—the smaller and more loosely constructed works—were forced to take orders at almost any prices to keep fires in their furnaces. (The United States stood Germany's iron industry in good stead in 1902.) Freight rates dropped for want of cargoes. The yearly report of the Hamburg Chamber of Commerce says: "The regular lines complain of want of cargoes for their greatly increased fleets." The Association of Berlin Merchants and Manufacturers, in their report, could discern "no trustworthy signs of a change of affairs as a whole." Exceptions there were as in some branches of the textile industry. Hermann Schüler, the Bochum banker, states that profits of most mines have gone back and that, owing to the extraordinary low prices of lead and ores, a "large number of works were on the verge of ruin at the end of the year." The great depression in the electric industry (firms are amalgamating with a view of improving matters, and there is a general move in this direction) reacted upon the technical chemical trade, although Germany's magnificent chemical industry failed to be affected by the general commercial conditions. Contrary to strong expectations, the closing of the Boer war had little or no effect on the situation—at any rate, nothing like that which was looked for.—Oliver J. D. Hughes, Consul-General at Coburg, Germany.

Agricultural Machines in Russia.—The German consul in Odessa, according to Das Handels Museum of August 6, in reporting to his government, says:

"A sharp competitive contest in the sale of agricultural machinery has just broken out in Russia. Great Britain has succeeded, by means of cheap sea freights, in securing the lead in the sales of steam threshers with locomotive attachments. Germany finds it hard to compete with the cheaper prices offered by the British merchants and manufacturers. America was once supreme in this field. Russia is making every effort to emancipate herself from foreign agricultural machines, particularly from gins and cutting, sawing, drilling, boring, hulling, and scutching machines. In gins and scutching machines Russia has progressed so far and so fast as to exclude German competition. Scutching machines are very light and pay an uncommonly high freight rate as a practically prohibited product; therefore it is not hard for Russia to build these more cheaply than she can buy them abroad or after they have been brought in. German gins get a preference over Russian because of the better cast iron used in the former. When, however, as almost always happens, the gins go in in single numbers, they are regarded as industrial rather than as agricultural machines and pay a much higher rate of duty. Nor does the fact that they serve agricultural purposes almost entirely make any difference. The number of gins imported is, therefore, much smaller than it otherwise would be. The mowing machines imported into Russia are mostly American. With these, neither Germany nor England can successfully compete.

"America and Germany send rakes. The German rakes, however, are bound to vanish entirely from the Russian market, since the teeth in comparison with the American leave much to be desired. Plows that formerly were imported mostly from Great Britain come very rarely from that country now, and were in 1901 mostly German. Although several German concerns have achieved distinction in this branch, it is cause for regret that many low-grade goods get into the Russian market to the no small injury of the reputation of the German product, thereby diminishing the demand. Russia produces a good one-share plow of her own, southern Russia turning out 200,000 every twelve months. This seems all the more remarkable when it is remembered that the duties are exceedingly low and German manufacturers are always able to put good plows on the Russian market at prices below those asked for the best Russian product. The great mistake made by the German plow makers is in not having Russia completely covered by competent traveling salesmen. They put their samples and interests into the hands of agents who lack business ability and energy, so that the traveling salesman of the active and energetic South Russian, although he works with little capital, often succeeds in obtaining big orders because the Germans are not in a position to fill them on time. The American plow has secured no remarkable advantage during the time under discussion. Germany sends large numbers of mowing machine knives. One often hears complaints about the poor quality of the goods delivered. The cause of the difference is due to the fact that many traveling salesmen of the Iserlohn (German) commission houses divide up their orders among a great many small manufacturers, thus getting anything but a uniform grade or class of goods. Many knives or machine blades are being bought in America, and it is to be feared that the German articles will be driven out if the present so-called Iserlohn system is not changed.

"The call for German steam threshing machines is nothing like what was looked for from Russia's increased demand. Russian competition, pupil of the German industry, is making progress in this line. The same thing is true in regard to chaff-cutting machines. For the first time Danish manufacturers appeared to advantage in the market. Russia offers Germany a market for milk separators that has never been worthily considered. The drums of the separators go in free of duty. Up to the present time Sweden and Denmark have supplied these. A factory in northern Russia imported the drums from Scandinavia, made the other parts itself, and put them all together.

"The demand for oil presses is growing greater. The favorite old-fashioned method of pressing the oil out by means of oak beams is giving way to modern methods and machines. South Russian factories have the advantage offered by being able to produce a simple, sensible oil press—one that finds favor and sells well.

"The Ural country, cis-Caucasia, Siberia, and Manchuria offer markets for all kinds of machines and apparatus. Machines for mills, bake shops, sugar refineries, distilleries, tanneries, etc., are needed. An agent with a knowledge of the lands and their languages would win in the effort to get markets. Such agents have helped Germany and the United States.

"Eastern Siberia offers an enormous field for iron and steel ware for building purposes; also for tools, etc., for carpenters and locksmiths. These lines are largely in the hands of Germans. There is also a large demand for guns and hunting material. The United States, by establishing a base of supply, leads all others in this line. The buyer in these far-off parts never bothers much about catalogues, particularly when he can get his hands or eyes on the object to be purchased. He prefers to pick from a large assortment and is willing to pay the price demanded, even though it is high."

Imports into the Transvaal.—The consular agents at Johannesburg and Pretoria have transmitted printed official returns showing the imports into the Transvaal during the five months ended May 31, 1892 and 1893. The statements are too long for publication in detail, but those interested therein are referred to Advance Sheets No. 1709, in which is printed a full list of the imports for the first three months of 1903, both lists being made up of similar articles.

The value of the imports into the Transvaal for the first five months of 1903, as given in the official returns, was as follows: From and via Natal, £4,176,741 ($20,326,308); from and via Cape Colony, £4,048,997 ($19,704,444); from and via Delagoa Bay, £1,536,628 ($7,477,802); total, £9,762,366 ($47,508,554)—being an excess over the five months of 1902 of £6,284,201 ($30,582,641).

Trade opportunities which the repairing of the waste of war is opening up in South Africa are important. The following leading articles in the list of Transvaal imports are selected as those wherein the United States can take a leading position. The values are given in round numbers:

Principal imports into the Transvaal, first five months of 1903.

Article.	Value.
Agricultural implements	$400,000
Animals (cattle, horses, mules and sheep, chiefly)	1,850,000
Chemicals and toilet articles	570,000
Cyanide of potassium	560,000
Apparel and slops	3,220,000
Boots and shoes	1,520,000
Butter	695,000
Cotton manufactures	860,000
Flour	1,095,000
Fruit, dried, fresh, and preserved	360,000
Furniture	1,610,000
Haberdashery and millinery	3 265,000
Hardware	1,995,000
Iron and steel (fencing ware and galvanized and corrugated iron, chiefly)	1,830,000
Groceries	545,000
Jewelry	270,000
Leather manufactures	515,000
Machinery, agricultural, electrical, manufacturing, etc., but chiefly mining	5,100,000
Meats, preserved and fresh	3,210,000
Milk, preserved	695 000
Mineral oil	135,000
Spirits (liquors)	965,000
Sugar	495,000
Vehicles (carts, carriages, wagons, bicycles, wheelbarrows, etc.)	1,465,000
Wood, rough and prepared	2,775,000
Total	$36,005,000

American Products in Fayal, Azores.—Consular Agent Moyses Benarus, under date of June 30, 1903, transmits the following statement showing the values of the products imported at Fayal from the United States during the fiscal year ended June 30, 1903:

Article.	Value.
Silk, woolen, and cotton goods	$10,178.00
Timber and lumber	19,000.00
Spars	500.00
Staves	364.00
Petroleum	1,733.11
Hardware, copper, iron, and zinc	1,644.17
Machinery and agricultural implements	4,606.80
Bicycles	247.12
Watches	339.11
Chemical products	297.08
Blacking	217.00
Tobacco	60.10
Beer	455.00
Tea	285.09
Codfish	98.08
Cordage	2,225.06
Miscellaneous merchandise	3,463.05
Total	$45,712.77

Mexican Fruit for the United States.—El Economista of August 22, says:

"Mexico promises to become a great fruit-growing country. It promises also to send considerable quantities of its fruits to the United States. The figures relating to the planting of fruit trees during recent years are very important. They have been planted all over the Republic, almost every section being well suited to fruit raising. While it is true that some fruit trees require years for their growth, there are others that yield rich crops in one, two, and three years. The plants that produce the pineapple, melon, and watermelon yield annual crops, and the demand in the United States is largest for just such fruit. The various kinds of bananas grow abundantly in the warmer parts of Mexico. These may be added in large quantities to the fruit exports to the United States."

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1813, November 30.—Reports: Regulations Concerning Foreign Commercial Agents—Australian Exodus—French Sugar Harvest of 1902-1903—African Trade Notes—Notes: Taxation in Cuba—Dock and Lighter Charges in Guatemala.

No. 1814, December 1.—Macaroni Wheat in Foreign Markets.

No. 1815, December 2.—Reports: Tariff and Port Charges in Honduras—*American vs. European Trade in Cuba—*American Products in Bradford—*How Canadian Fruit is Exported—Permanent Finishes for Cloth—Notes: Mexican Coal—Swedish Trade and Industries—*Opportunity for American Investment—Gold Production of the Transvaal.

No. 1816, December 3.—Reports: European Trade Notes—*How to Enlarge Trade in South Africa—Increased Railway Freight Rates in Mexico—Iron and Steel Trade of the United Kingdom—Electrotechnical Industry of Germany—Notes: German Pig-Iron Syndicate—Warning to Grain Exporters—*American and Canadian Cheese in England—Consumption of Fish in Germany—German Sample Warerooms in Foreign Countries—Paris Automobile, Bicycle and Sporting Goods Exposition—Increased Duties on Matches in Venezuela—Arsenically Dyed Goods Prohibited in Sweden—Customs Duties on Returned German Goods.

No. 1817, December 4.—Commerce and Industries of Colon and Panama.

No. 1818, December 5.—Reports: *American Industrial Capital in Hamilton, Canada—*Ready-made Clothing in Mexico—*Commercial Museum in the Philippines—*British Department of Commerce Suggested—Russian Grain Shipment Regulations—Notes: Increase in the German Consular Corps—*Opening for American Steel in Italy—Land Carriage and Aeronautic Exhibition in Italy—*Peg-making Machines.

Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

SELECTED FORMULÆ.

Liquid Cement.—

Glue	3 ounces
Gelatine	3 ounces
Acetic acid	4 ounces
Water	2 ounces
Alum	30 grains

Heat together for six hours, skim, and add:

Alcohol	1 fl. ounce

—Spatula.

Rose Sachet.—

Orris root	200 parts
Rose leaves	600 parts
Sandalwood	100 parts
Patchouly	100 parts
Oil of rose geranium	3 parts
Oil of rose	2 parts

—Spatula.

Polishing Paste.—

Infusorial earth (Kieselguhr)	8 ounces
Paraffin	2 ounces
Lubricating oil	6 fl. ounces
Oleic acid	1 fl. ounce
Oil mirbane	30 minims

Melt the paraffin with the lubricating oil, and mix with the infusorial earth, then add the oleic acid and oil of mirbane.—Spatula.

Restoring Tarnished Gold.—

Sodium bicarbonate	20 ounces
Chlorinated lime	1 ounce
Common salt	1 ounce
Water	16 ounces

Mix well and apply with a soft brush.

A very small quantity of the solution is sufficient for effecting the desired purpose, and it may be used either cold or lukewarm. Plain articles may be brightened equal to new by putting a spot or two of the liquid upon them from the stopper of the bottle and lightly brushing over the surface with fine tissue paper until sufficiently dried off to accomplish the object intended.—Drug. Circ.

Soap Bubble Liquid.—

I.

White hard soap	25 parts
Glycerin	15 parts
Water	1,000 parts

II.

Dry castile soap	2 parts
Glycerin	30 parts
Water	40 parts

III.

Palm soap	4 parts
Glycerin	32 parts
Water	32 parts

—Drug Circ.

Polish for Aluminium.—

Stearic acid	1 part
Fuller's earth	1 part
Tripoli	6 parts

A mixture of petroleum and kerosene oil is said to be an excellent application for protecting the surface of the metal.

To give the aluminium a natural, pure white color, dip it into a strong solution of caustic soda or potassa, and then into a bath of 2 parts of nitric and 1 part of sulphuric acid; thence into pure nitric acid, and finally into vinegar diluted with water. Rinse in running water, and dry in hot sawdust. Burnish with a bloodstone burnisher.—Drug. Circ.

Envelope Gum.—The gum used by the United States government on postage stamps is probably one of the best that could be used not only for envelopes but for labels as well. It will stick to almost any surface. Its composition is said to be the following:

Gum arabic	1 part
Starch	1 part
Sugar	4 parts
Water, sufficient to give the desired consistency.	

The gum arabic is first dissolved in some water, the sugar added, then the starch, after which the mixture is boiled for a few minutes in order to dissolve the starch, after which it is thinned down to the desired consistency.

Cheaper envelope gums can be made by substituting dextrin for the gum arabic, glucose for the sugar and adding boric acid to preserve and help stiffen it.—Drug. Circ.

Pencils for Writing on Glass.—According to Lehner's work on ink manufacture the pencils used in laboratories for writing on glassware, porcelain and metal contain the following ingredients:

Black.

Soot	10 parts
Wax	40 parts
Tallow	10 parts

White.

Chalk	40 parts
Wax	20 parts
Tallow	10 parts

Pale Blue.

Prussian blue	10 parts
Wax	20 parts
Tallow	10 parts

Dark Blue.

Prussian blue	15 parts
Gum (acacia?)	5 parts
Tallow	10 parts

Red.

Cinnabar	20 parts
Wax	60 parts
Tallow	20 parts

Yellow.

Chrome yellow	10 parts
Wax	20 parts
Tallow	10 parts

The ingredients are thoroughly mixed and shaped into sticks by great pressure. The sticks are then incased in wood as in lead pencils.—Drug. Circ.

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